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Final Report

Air Quality Monitoring in the County of Grande Prairie

December 1998 to August 2000

Alberta
ENVIRONMENT

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Air Quality Monitoring in the County of Grande Prairie

Final Report

December 1998 to August 2000

Prepared by:

Alberta Environment

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Summary

Alberta Environment conducted a comprehensive air quality monitoring survey in the County of Grande Prairie from December 1998 to August 2000. Monitoring took place in a rural area west, northwest and northeast of the City of Grande Prairie between Townships 70 and 76 to the Alberta/British Columbia border. The focus was to collect air quality data downwind of industrial facilities and at communities in the area. The survey was undertaken in response to air quality concerns from residents in the County of Grande Prairie. Three types of monitoring techniques were used. These are discussed below.

(1) The *Mobile Air Monitoring Laboratory* (MAML) was used at 28 sites to monitor for major air quality parameters including one-hour average concentrations of sulphur dioxide, hydrogen sulphide, hydrocarbons, particulates, ozone, oxides of nitrogen, carbon monoxide and ammonia using continuous analyzers. Three hundred and forty hours of data were collected on 48 days from December 1998 to October 1999 by the MAML.
(2) Air samples were collected near industries and analyzed for major volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene and xylenes. Eighty VOC samples were collected at 21 sites during the survey.
(3) A passive (no power required) air quality monitoring network was set up to collect monthly air samples for sulphur dioxide and ozone. Thirty sulphur dioxide and 7 ozone sites collected monthly air quality samples over fourteen months from July 1999 to August 2000.

Results and Conclusions

Ambient levels of all air quality parameters measured by the MAML were below the Alberta Ambient Air Quality Guidelines. The maximum one-hour sulphur dioxide concentration measured during the survey was 0.043 parts per million (ppm). This value is well below Alberta's one-hour guideline of 0.172 ppm. The highest one-hour hydrogen sulphide concentration recorded during the survey was 0.009 ppm and is lower than the one-hour guideline of 0.010 ppm. Concentrations of carbon monoxide, nitrogen dioxide, ozone and ammonia were also lower than Alberta's Ambient Air Quality Guidelines. The Alberta Ambient Air Quality Guidelines are part of the Alberta air quality management system. This system was designed to ensure that emissions are minimized through the use of Best Available Demonstrated Technology (BADT), and that residual emissions are dispersed so that the guidelines are met. These guidelines are some of the most stringent in North America.

Hydrocarbon levels measured by the MAML were above typical natural background levels at several monitoring sites. The highest hydrocarbon levels were measured near an oil battery at Site #26 (see map on page six for monitoring site locations) where the maximum recorded one-hour total hydrocarbon concentration was 16 times higher than typical background levels. The maximum one-hour total hydrocarbon concentration measured at Site #26 was 32 ppm compared to normal, natural backgrounds levels of about 2 ppm. However, the results of nine VOC

samples collected at this site showed that concentrations of individual hydrocarbons such as benzene, toluene, ethylbenzene and xylenes were lower than Alberta's Ambient Air Quality Guidelines and Ontario's Air Quality Standards, which are the most restrictive in North America. Hydrocarbons measured at Site #26 were likely caused by leakages from petroleum storage tanks, and from the loading and unloading of petroleum transport vehicles at a nearby oil battery.

The one-hour guideline for benzene was exceeded in five VOC samples collected directly downwind of industrial sources in the County of Grande Prairie. These samples were usually collected within 10 metres of the fence line of the industrial facility. Benzene concentrations from samples collected further downwind from oil and gas facilities showed low benzene levels. Therefore, it is expected that ambient benzene levels at the closest residence to these facilities would be very low compared to the one-hour guideline. In the remaining 75 VOC samples collected during the County of Grande Prairie survey, benzene levels were lower than the one-hour guideline.

The Alberta one-hour guideline for benzene is the most stringent in North America, and is 100 times more stringent than the U.S. Department of Health and Human Services permissible exposure limit for benzene levels in the workplace.

High particulate levels were measured by the MAML at monitoring sites located near gravel roads with relatively high traffic volumes. The highest total suspended particulate (TSP), inhalable particulate (PM_{10}) and respirable particulate ($PM_{2.5}$) concentrations were measured near the Village of Hythe (Site #10) and near two industrial facilities (Site #6 and #19). High particulate levels recorded during the survey were caused by road dust from traffic along roads adjacent to the monitoring locations.

Ozone levels measured by the MAML and the passive monitoring network showed concentrations that were typical of other rural locations in Alberta. The maximum one-hour ozone concentration recorded during the survey was 0.064 ppm compared to the one-hour guideline of 0.082 ppm. The highest hourly ozone concentrations were measured in the spring and early summer. The majority of the ozone at rural locations in the County of Grande Prairie is the result of natural processes such as: (1) transport from the "ozone-rich" upper atmosphere; and (2) organic compounds (from vegetation) reacting with and oxides of nitrogen in the presence of sunlight to form ozone.

The results from the 30 passive sulphur dioxide sites set up from July 1999 to August 2000 showed that monthly sulphur dioxide concentrations were generally low. The highest monthly sulphur dioxide concentration recorded over the 14-month monitoring period was 3.4 parts per billion (ppb). The highest 14-month average concentration measured for the entire network was 1.5 ppb. This value is very low compared to Alberta's 12-month air quality guideline for sulphur dioxide of 10 ppb.

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Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
BTEX	benzene, toluene, ethylbenzene and xylenes
CH_4	methane
CO	carbon monoxide
H_2S	hydrogen sulphide
km/h	kilometres per hour
MAML	Mobile Air Monitoring Laboratory
NH_3	ammonia
NO	nitric oxide
NO_X	total oxides of nitrogen
NO_2	nitrogen dioxide
O_3	ozone
PAHs	polycyclic aromatic hydrocarbons
ppb	parts per billion by volume
ppm	parts per million by volume
$PM_{2.5}$	particulates less than 2.5 micrometres in diameter (respirable particulates)
PM_{10}	particulates less than 10 micrometres in diameter (inhalable particulates)
PSD	passive sampling device
PSL1	Environment Canada First Priority Substance List
PSL2	Environment Canada Second Priority Substance List
RH	relative humidity
RHC	reactive hydrocarbons
SIA	Strathcona Industrial Association
SO_2	sulphur dioxide
Temp.	temperature
THC	total hydrocarbons
TRS	total reduced sulphur
TSP	total suspended particulates
VOCs	volatile organic compounds
WBEA	Wood Buffalo Environmental Association
WCAS	West Central Airshed Society
WDR	wind direction
WSP	wind speed
$\mu g/m^3$	micrograms per cubic metre of air

Introduction

A comprehensive air quality monitoring survey was conducted near industries and in communities in the County of Grande Prairie survey area from December 1998 to August 2000. The survey was initiated in response to public concerns about air quality in the County of Grande Prairie.

The objectives of the survey were to:

(1) determine maximum air quality levels in the region.
(2) map the distribution of air quality within the County.
(3) compare air quality levels to Alberta's Ambient Air Quality Guidelines.
(4) present air quality data collected in the County of Grande Prairie relative to other locations in Alberta.

Monitoring was conducted in a rural area in the County of Grande Prairie between Townships 70 and 76 to the Alberta/British Columbia border (see map on page six). Three types of monitoring were used to assess air quality in the survey area.

The Alberta Environment *Mobile Air Monitoring Laboratory* (MAML) was used to monitor air quality in the County of Grande Prairie. Parameters measured by the MAML included sulphur dioxide, hydrogen sulphide, total reduced sulphur, hydrocarbons, particulates, oxides of nitrogen, ozone, carbon monoxide and ammonia. The MAML monitored in the County of Grande Prairie for 48 days between December 1998 and October 1999. Alberta Environment routinely conducts unannounced monitoring surveys using the MAML. In 1999, Alberta Environment conducted 14 mobile monitoring surveys within the province.

In addition to using the MAML, monitoring was conducted by collecting air samples and analyzing the samples for specific volatile organic compounds (VOCs). These air samples were collected primarily when the MAML operator detected odours or elevated hydrocarbon levels were measured by the MAML. VOC samples were collected at 21 locations during the survey. These samples were collected for one- to 24-hour time periods and were analyzed for benzene, toluene, ethylbenzene and xylenes.

Air quality monitoring was also conducted for sulphur dioxide and ozone using passive methods. Since passive monitoring does not require power, air samples can be collected for an extended period of time. In the County of Grande Prairie survey, passive monitoring techniques were used to monitor sulphur dioxide at 30 sites and ozone at seven sites. These samples were collected on a monthly basis for 14 months, from July 1999 to August 2000.

This report presents the results of the monitoring survey in three parts. These are:

Part 1: Monitoring Using the Mobile Air Monitoring Laboratory
Part 2: Monitoring for Volatile Organic Compounds
Part 3: Passive Monitoring for Sulphur Dioxide and Ozone

Part 1: Monitoring Using the Mobile Air Monitoring Laboratory

Alberta Environment used the *Mobile Air Monitoring Laboratory* (MAML) to monitor air quality on forty-eight days, in the County of Grande Prairie between December 1998 and October 1999. The focus of this monitoring was to collect air quality data downwind of industrial sources in the area and to compare the data to Alberta's Ambient Air Quality Guidelines. Air quality was monitored on the following dates representing the winter, spring, summer and fall seasons.

- Winter (December 1 to 6 and December 10 to 15, 1998).
- Spring (April 8 to 13 and April 16 to 21, 1999).
- Summer (June 15 to 20 and June 23 to 28, 1999).
- Fall (October 14 to 19 and 22 to 27, 1999).

The MAML monitored air quality at 28 sites in the County of Grande Prairie (see Table 1.3 on page five and Figure 1.2 on page six for locations). The majority of these sites were located downwind of oil and gas facilities. An attempt was made to monitor at the nearest road access downwind of each facility (usually within 500m of the facility). Monitoring was also conducted in Hythe, Sexsmith and Teepee Creek, and at the Agriculture and Agri-Food Canada Research Farm near Beaverlodge. Monitoring was conducted for a minimum of one hour at each location to allow comparison with Alberta's ambient air quality guidelines.

The initial monitoring sites were selected based on consultation with regional staff from Alberta Environment and the Alberta Energy and Utilities Board. Potential monitoring sites were determined through a field assessment prior to the start of the monitoring survey. Monitoring locations were reviewed as the survey progressed and modified based on concerns indicated through public complaints or observations by the MAML operators.

Alberta Environment also operates a permanent air quality station at the Agriculture and Agri-Food Canada Research Farm near Beaverlodge (see Figure 1.1). Parameters monitored on a continuous basis at this station include sulphur dioxide, oxides of nitrogen, ozone, wind direction, wind speed, temperature and relative humidity. This station also monitors for wet and dry acidic deposition. Data from this station is included for reference in this report.

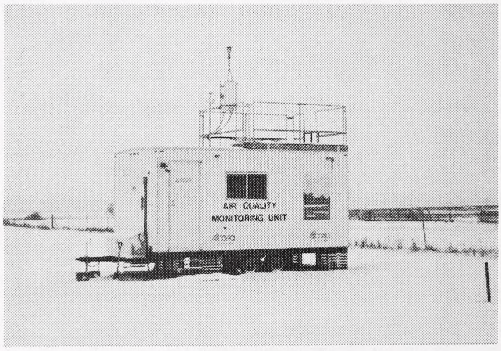

Figure 1.1 Beaverlodge air quality monitoring unit.

The Mobile Air Monitoring Laboratory

The MAML is a 27-foot (8.2 m) vehicle that has been specially designed and equipped to measure air quality. It houses a variety of instruments that continuously sample the air at specified time or distance intervals. The MAML is equipped with:

- a dual computer system custom-programmed to accept and record the measurement of air samples from each analyzer.

- a GPS (Global Positioning System) that identifies the MAML's location as it moves around Alberta.
- an exhaust purifying system that minimizes emissions from the vehicle.
- two on-board generators that are also equipped with exhaust scrubbers.

The parameters measured by the MAML during the County of Grande Prairie survey are indicated in Table 1.1. Air quality parameter concentrations, weather conditions and the MAML operator's comments for each location monitored are indicated in Appendix A of this report. Appendix A also contains median and maximum air parameter concentrations at all sites during the survey and typical median and maximum air parameter concentrations at other locations in Alberta.

Figure 1.2 Alberta Environment's Mobile Air Monitoring Laboratory (MAML).

Alberta's Ambient Air Quality Guidelines

Alberta's Ambient Air Quality Guidelines[1] are established under Section 14 of the Environmental Protection and Enhancement Act (EPEA). EPEA provides for the development of guidelines and ambient environmental quality objectives for all or part of Alberta.

The Ambient Air Quality Guidelines are used for:

- reporting on the state of the atmospheric environment in Alberta.
- reporting to Albertans on the quality of air through an air quality index.
- establishing approval conditions for regulated industrial facilities.
- evaluating proposals to construct facilities that will have air emissions.
- guiding special ambient air quality surveys.
- assessing compliance near major industrial air emission sources.

Alberta's Ambient Air Quality Guidelines for one-hour concentrations of parameters monitored by the MAML are indicated in Table 1.2.

Some of Alberta's Ambient Air Quality Guidelines are based on odour perception. This is the case for sulphur dioxide, hydrogen sulphide, ammonia and nitrogen dioxide. For these chemicals, people are likely to detect an odour at concentrations well below levels that may affect human health.

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[1] *Alberta Ambient Air Quality Guidelines.* Alberta Environment. February 2000.

Table 1.1 Parameters monitored by the MAML in the County of Grande Prairie survey (also includes minimum detection limits and operating ranges).

Parameter Measured	Minimum Detectable Limit*	Operating Range**
sulphur dioxide (SO_2)	0.6 ppb	1 ppm
hydrogen sulphide (H_2S)	0.6 ppb	1 ppm
total reduced sulphur (TRS)	0.6 ppb	1 ppm
total hydrocarbons (THC)	0.005 ppm	20 ppm
reactive hydrocarbons (RHC)	0.005 ppm	20 ppm
methane (CH_4)	0.005 ppm	10 ppm
polycyclic aromatic hydrocarbons (PAHs)	3 ng/m^3	1000 ng/m^3
ozone (O_3)	0.001 ppm	0.5 ppm
nitrogen dioxide (NO_2)	1.0 ppb	1 ppm
nitric oxide (NO)	1.0 ppb	1 ppm
total oxides of nitrogen (NO_x)	1.0 ppb	1 ppm
total suspended particulates (TSP)	1 µg/m^3	1.0 g/m^3
inhalable particulates (PM_{10})	1 µg/m^3	1.0 g/m^3
respirable particulates ($PM_{2.5}$)	1 µg/m^3	1.0 g/m^3
carbon monoxide (CO)	0.1 ppm	50 ppm
ammonia (NH_3)	1.0 ppb	5 ppm
wind direction (WDR)	0 degrees	360 degrees
wind speed (WSP)	0 kph	200 kph
temperature (Temp)	-40 °C	50 °C
relative humidity (RH)	0 %	100 %

ppb = parts per billion
µg/m^3 = micrograms per cubic metre
°C = degrees Celsius
ppm = parts per million
g/m^3 = grams per cubic metre
% = per cent
ng/m^3 = nanograms per cubic metre
kph = kilometres per hour

* The ***minimum detectable limit*** indicates the *minimum* amount of pollutant the instrument can measure.

** The ***operating range*** indicates the *maximum* amount of pollutant the instrument can detect. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are monitored) is then compromised.

Table 1.2 Alberta's Ambient Air Quality Guidelines for parameters measured by the MAML.

Air Quality Parameter	One-hour Guideline (ppm*)	Basis for Guideline
hydrogen sulphide	0.01	odour perception
ammonia	2	odour perception
carbon monoxide	13	oxygen carrying capacity of blood
nitrogen dioxide	0.212	odour perception
ozone	0.082	reduction of lung function and effects on tomatoes
sulphur dioxide	0.172	taste, odour perception and effects on bluegrass

* Parts per million by volume.

Table 1.3 List of site numbers and associated locations monitored by the MAML.

Site #	Nearest Facility or Community	Location of Monitoring Site or Facility	# of Hours Monitored
Site #1	Canadian Hunter Elmworth gas plant	SE 8-70-11 W6	8
Site #2	Beaverlodge Agriculture Research Farm	NE 2-72-10 W6	16
Site #3	Crestar Energy Goodfare gas plant and battery station	SE 19-72-11 W6; NE 19-72-11 W6; NW 18-72-11 W6	15
Site #4	Locality of Lymburn	SW 28-73-12 W6, SE 28-73-12 W6	14
Site #5	Brainard Area	NE 3 -74-12 W6, SE 2 -74-12 W6, NW 2 -74-12 W6, SE 1 -74-12 W6	14
Site #6	AEC West Hythe Brainard gas plant	NE 7-74-12 W6, NE 18-74-12 W6, NW 13-74-13 W6	18
Site #7	Alberta/BC Border	SE 16-75-13 W6, NE 9-75-13 W6	5
Site #8	Martin Lake area (1 km W of Rge Rd 113 on Twp Rd 744)	NW 23-74-11 W6	11
Site #9	UPR Knopcik gas plant	SW 10-74-11 W6, NE 10-74-11 W6	17
Site #10	Village of Hythe	SW 24-73-11 W6, SE 23-73-11 W6	16
Site #11	Rigel Knopcik gas plant	NW 21-73-10 W6, NE 21-73-10 W6	15
Site #12	Rigel Hythe gas battery	SE 16-73-9 W6, SW 15-73-9 W6, SE 15-73-9 W6, NE 15-73-9 W6	15
Site #13	East facility: Crestar Energy Valhalla gas plant	NE 30-75-9 W6, NE 29-75-9 W6, SE 29-75-9 W6, NE 20-75-9 W6	21
	West facility: Anderson Oil and Gas Valhalla facility	LSD 8-30-75-9 W6	
Site #14	AEC West Valhalla oil battery 3	SW 27-75-9 W6, SW 28-75-9 W6	12
Site #15	Crestar Energy well site	NE 10-75-9 W6	2.4
Site #16	Petro Canada Valhalla gas plant	SE 1-75-9 W6, NE 12-75-9 W6, SE 12-75-9 W6	14
Site #17	AEC West Valhalla battery 10	NE 13-74-8/9 W6, NE 18-74-8 W6, 18&19-74-8 W6	14
Site #18	Crestar Energy Wembley gas plant	NE 19-73-8 W6, NW 19-73-8 W6, SW 30-73-8 W6	17
Site #19	West facility: Peace Pipeline La Glace pump station	NW 7-73-8 W6, NE 7-73-8 W6, SE 17-73-8 W6	17
	East facility: CCS La Glace oilfield waste disposal facility	LSD 12-8-73-8 W6	
Site #20	AEC West Saddle Hills gas plant (Sexsmith)	SW 8-75-7 W6, NE 8-75-7 W6, NE 17-75-7 W6	17
Site #21	Talisman Energy Teepee Creek gas plant	SW 2-74-4 W6, SE 2-74-4 W6	15
Site #22	Community of Teepee Creek	SE 5-74-3 W6	7
Site #23	Town of Sexsmith	SE 24-73-6 W6, NE 25-73-6 W6, SE 36-73-6 W6	10
Site #24	Talisman Energy Manir Battery	LSD 8-21-72-3 W6	9
Site #25	Huber gas well	SE-25-73-6 W6	7
Site #26	Crestar Energy Valhalla oil battery/waterflood	LSD 16-11-75-9 W6	10.4
Site #27	AEC West well site	LSD 16-2-74-6 W6	2
Site #28	Talisman Energy well site	LSD 14-36-72-6 W6	2

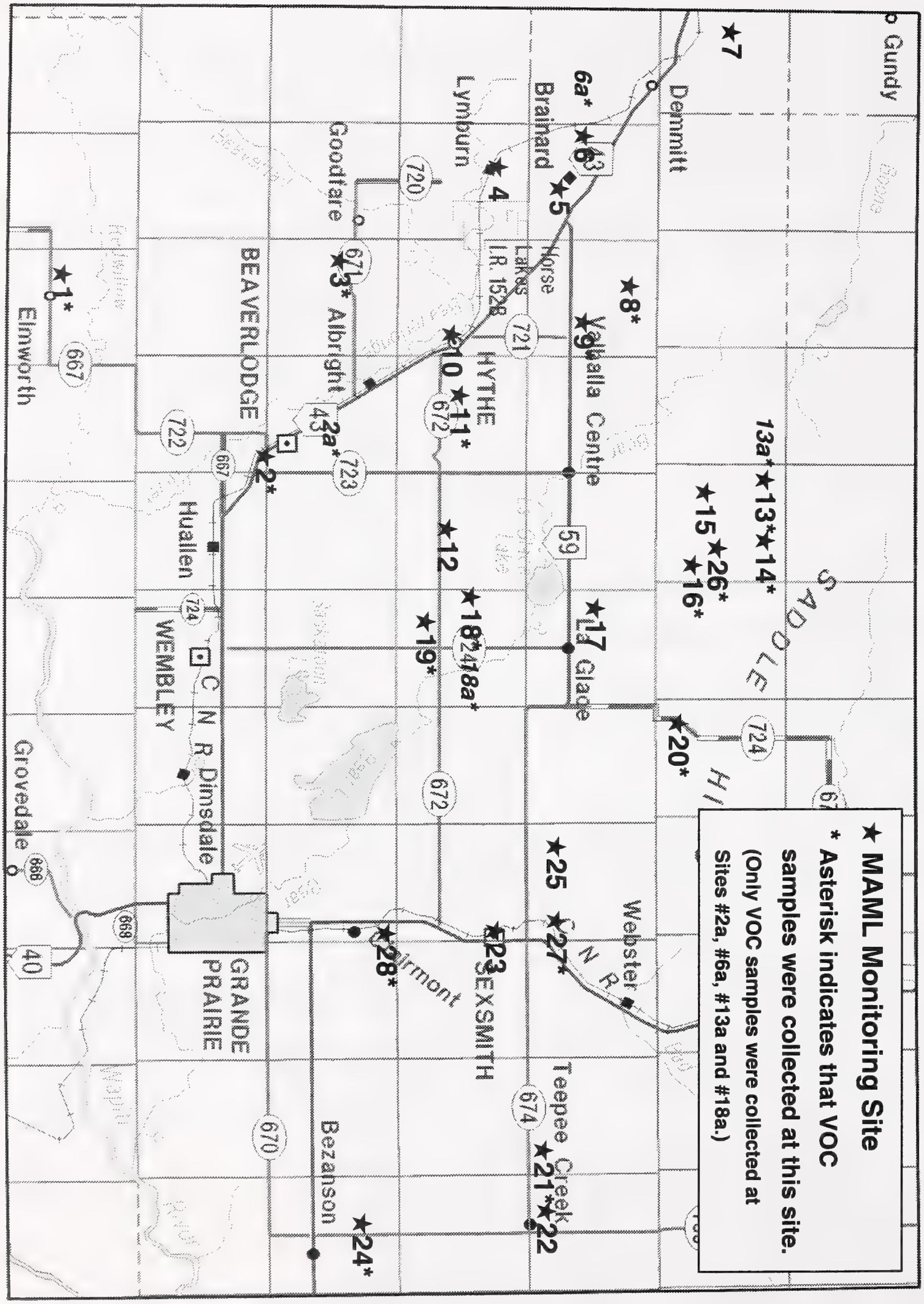

Figure 1.3 Location of sites monitored by the MAML in the County of Grande Prairie.

Sulphur Dioxide (SO_2)

Maximum one-hour concentration recorded during survey	One-hour guideline
0.043 ppm	0.172 ppm (based on taste, odour perception and effects on bluegrass)

Sulphur dioxide (SO_2) is a colourless gas with a pungent odour. In Alberta, it is estimated that 45% of SO_2 emissions are produced by natural gas processing plants while oil sands and power plants produce about 26% and 21% of SO_2 emissions, respectively[2]. Other sources include gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.

SO_2 levels were below Alberta's one-hour guideline at all sites monitored during the County of Grande Prairie survey (see Figure 1.4). The maximum one-hour concentration of 0.043 ppm was measured at Site #20 from 1:25 p.m. to 2:29 p.m. on April 16, 1999. This value is 25% of the one-hour guideline for SO_2. Maximum one-hour concentrations at Sites #13, #14, #18 and #21 ranged from 0.016 ppm to 0.021 ppm. These maximum values are from 9 to 12% of the one-hour guideline. Maximum SO_2 levels at the remaining monitoring sites were very low (0.008 ppm or lower).

The maximum one-hour SO_2 concentration measured in the County of Grande Prairie survey (0.043 ppm) was within the range of typical maximum one-hour values that are measured at other locations in Alberta. Based on 1999 data at 16 permanent stations (see Tables A.3 and A.4 in Appendix A), maximum one-hour SO_2 concentrations ranged from 0.016 ppm at the Beaverlodge station to 0.168 ppm at a station in the Fort McMurray area. The maximum SO_2 concentration measured in a similar air quality survey conducted near oil and gas industrial sources in the Caroline/Sundre area in 1997/98 was also 0.043 ppm.

Median SO_2 levels during the entire County of Grande Prairie survey were also low with the highest median value measured at Site #21 (0.006 ppm). Median SO_2 concentrations were 0.003 ppm or lower at the remaining monitoring sites.

The overall median concentration from all sites monitored during the survey was 0.001 ppm, based on 340 hours of data. Typical median SO_2 concentrations at permanent monitoring stations in Alberta range from less than the instrument detection limit (0.0006 ppm) to 0.003 ppm (based on 1999 data from 16 stations). The median SO_2 concentration at the Beaverlodge monitoring station in 1999 was less than the instrument detection limit.

The **median concentration** is a common way of representing the central value for environmental data. Most environmental data usually consist of a distribution that is skewed to the right; that is most data values are low and only a few are high. The arithmetic mean will be biased by the high concentrations and will reveal a value that may not be representative of the central value for the data. The median is the middlemost value in the data, dividing the distribution into two equal halves. Therefore, the median is more representative of the central value of the data distribution.

For example, consider a data distribution consisting of five numbers: 1,2,2,2,3 and 10. The arithmetic mean of these data is 3.6 and median is 2. In this case, the arithmetic mean is biased high by the extreme value of 10. The median value is actually a true central value of the data distribution.

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[2] Environment Canada. 1998. *1995 Criteria Air Contaminant Emissions Inventory Summaries.* Pollution Data Branch, Environment Canada. http://www2.ec.gc.ca/pdb/cac/cac.html.

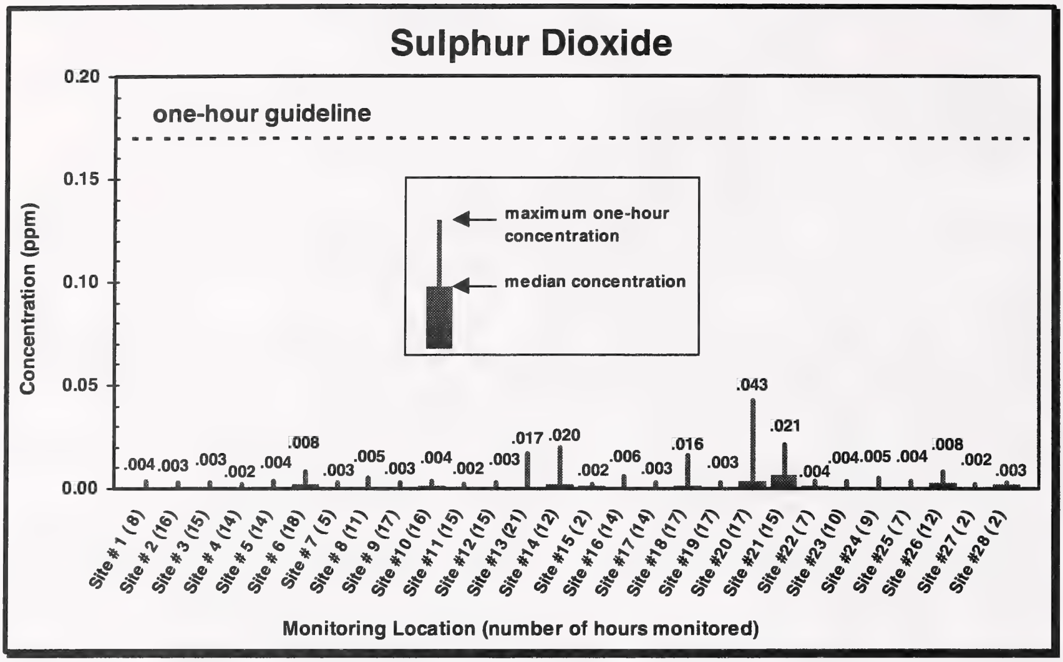


Figure 1.4 One-hour median and maximum concentrations for sulphur dioxide.

Hydrogen Sulphide and Total Reduced Sulphur (H_2S and TRS)

Maximum one-hour concentration recorded during survey	One-hour guideline
H_2S = 0.009 ppm	0.010 ppm (based on odour perception)
TRS = 0.010 ppm	no guideline

Hydrogen sulphide (H_2S) is a colourless gas with a rotten egg odour. Total reduced sulphur (TRS) includes hydrogen sulphide, mercaptans, dimethyl sulphide, dimethyl disulphide and other sulphur compounds. Sulphur dioxide is not included in the determination of TRS. Industrial sources of H_2S and TRS include fugitive emissions (leakages) from petroleum refineries, tank farms for unrefined petroleum products, natural gas plants, petrochemical plants, oil sands plants, sewage treatment facilities, pulp and paper plants that use the Kraft pulping process, and animal feedlots. Natural sources of H_2S include sulphur hot springs, sloughs, swamps and lakes.

As indicated in Figure 1.6, H_2S concentrations were below Alberta's one-hour air quality guideline at all locations monitored during the survey. The maximum one-hour H_2S concentration was measured at Site #18 on December 1, 1998 from 6:29 p.m. to 7:30 p.m. The one-hour concentration measured during this period was 0.009 ppm, slightly lower that the one-hour guideline of 0.010 ppm. The second highest H_2S concentration was measured during the following hour (7:34 p.m. to 8:38 p.m.) at Site #18 with a value of 0.007 ppm. The maximum one-hour TRS concentration of 0.010 ppm was also recorded at Site #18 on December 1, 1998. Possible sources of H_2S at Site #18 include fugitive emissions from nearby industrial facilities (see Figure 1.5).

The next highest one-hour H_2S concentration of 0.006 ppm was measured at Site #21 from 10:21 a.m. to 11:21 a.m. on April 9, 1999. Maximum one-hour H_2S values were 0.004 ppm or lower at the remaining sites monitored during the survey.

H_2S concentrations will sometimes exceed the one-hour, odour based, guideline at monitoring locations situated close to H_2S sources. For example, the maximum one-hour H_2S concentration measured at the Edmonton East and Calgary East monitoring stations in 1999 were 0.017 and 0.019 ppm, respectively compared to a maximum value of 0.009 ppm measured in the County of Grande Prairie survey. The maximum one-hour H_2S concentration measured in a similar survey conducted in the Caroline/Sundre area in 1997/98 was 0.008 ppm.

Median H_2S levels were low at all monitoring sites. The highest median H_2S concentration of 0.002 ppm was measured at Site #21. The median H_2S concentration based on all data collected in the County of Grande Prairie survey was below the detection limit of the instrument. Typical median H_2S concentrations at other locations in Alberta are also close to the instrument detection limit.

Figure 1.5 Petroleum storage tanks located near Site #18.

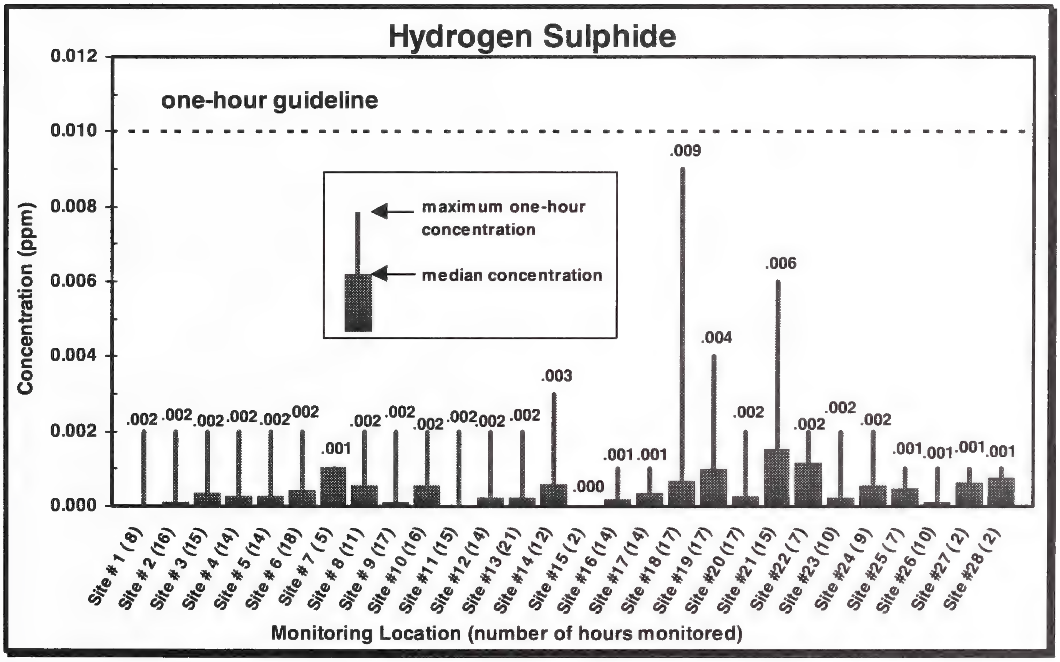


Figure 1.6 One-hour median and maximum concentrations for hydrogen sulphide.

Hydrocarbons (THC, RHC and CH_4)

Maximum one-hour concentration recorded during survey	One-hour guideline
THC > 32.4 ppm	no guideline
RHC > 29.4 ppm	no guideline
CH_4 > 6.4 ppm	no guideline

The term "total hydrocarbons" (THC) refers to a broad family of chemicals that contain carbon and hydrogen atoms. Methane (CH_4), a non-reactive hydrocarbon, is the most common hydrocarbon in the earth's atmosphere. Specific reactive hydrocarbons (RHC) are important because: (1) they can react with oxides of nitrogen in the presence of sunlight to form ozone; and (2) they can be toxic (at high concentrations) to humans, animals or vegetation. Sources of hydrocarbons include vegetation, vehicle emissions, gasoline marketing and storage tanks, petroleum and chemical industries, dry cleaning, fireplaces, natural gas combustion and aircraft traffic. Hydrocarbons are also emitted by fugitive sources such as evaporation of solvents, or leaking valves, flanges, pumps and compressors at industrial facilities. Incinerator and flare stacks can also be sources of hydrocarbons.

Many hydrocarbons, such as CH_4, are emitted by natural sources. Normal background THC concentrations recorded in rural Alberta range from 1.5 to 2 ppm. Background hydrocarbons are primarily composed of CH_4 with a small contribution from RHC (about 0.2 ppm).

Hydrocarbon concentrations were well above typical background levels at Sites #26, #13, #3 and #18. Median and maximum hydrocarbon concentrations at each site are indicated in Figures 1.8 to 1.10.

The highest hydrocarbon (THC, RHC and CH_4) concentrations were measured at Site #26 for two consecutive hours from 10:13 a.m. to 12:21 p.m. on October 16, 1999 (see Figure 1.7). The one-hour average THC concentrations recorded during these two hours were greater than 32.4 ppm (from 10:13 to 11:12 a.m.) and greater than 32.2 ppm (from 11:13 a.m. to 12:21 p.m.). Actual hydrocarbon concentrations were higher than the upper operating range of the hydrocarbon monitoring instrument of 50 ppm for 24 minutes during this monitoring period. Therefore, the THC concentration was greater than 50 ppm during these 24 minutes.

THC concentrations substantially higher than background levels were also recorded at Site #26 on April 19, 1999 (>13 ppm), June 27, 1999 (6.6 ppm), October 19, 1999 (8.3 ppm), October 24, 1999 (8.0 ppm) and October 27, 1999 (5.7 ppm). The MAML operators noted strong petroleum-like odours during many of these episodes. The most likely cause of these high hydrocarbon levels at Site #26 was fugitive emissions, or leakages, from petroleum storage tanks. Loading and unloading of petroleum transport vehicles on the facility site at Site #26 may have also contributed to high levels of hydrocarbons.

A total of nine Carbotrap tube air samples were set out at Site #26 to further identify individual hydrocarbons. Concentrations of benzene, toluene, ethylbenzene and xylenes in these air samples were below Alberta's Air Quality Guidelines and Ontario's Air Quality Standards. The results of this analysis are presented in Part 2 of this report.

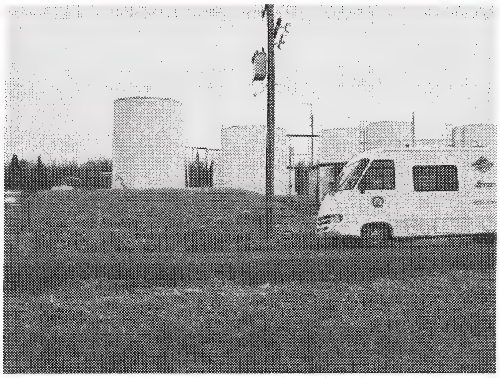


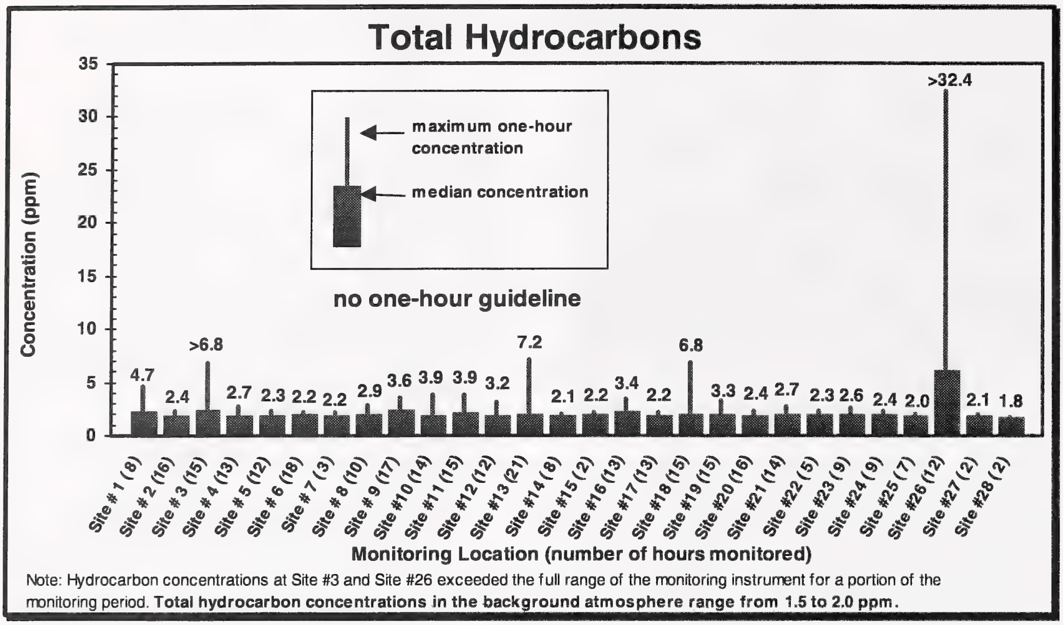
Figure 1.7 MAML monitoring at Site #26 on October 16, 1999.

The maximum one-hour THC concentration at Site #13 (7.2 ppm) was measured on December 2, 1998 from 5:34 p.m. to 6:53 p.m. A maximum one-hour THC concentration of greater than 6.8 ppm was recorded at Site #3 and 6.8 ppm at Site #18. These maximum values occurred on October 23, 1999 (8:08 a.m. to 9:09 a.m.) at Site #3 and on December 1, 1998 (6:29 p.m. to 7:30 p.m.) at Site #18. A Carbotrap tube air sample was collected on the October 23 survey day at Site #3 to determine individual hydrocarbon species (see Part 2 of this report). High hydrocarbon levels at these three monitoring sites were likely due to fugitive emissions from near-by oil and gas facilities.

Hydrocarbon concentrations well above background levels have been measured at other monitoring locations in Alberta located near industrial sources. Based on 1999 data from 15 permanent monitoring stations, maximum one-hour THC concentrations range from 3.5 ppm to 19.9 ppm.

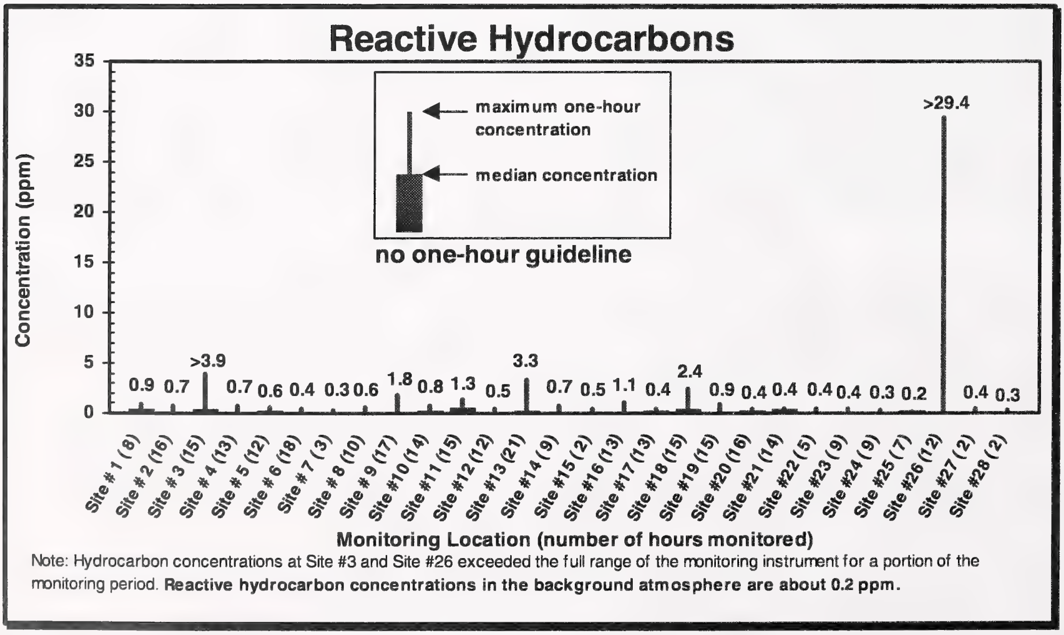
In the County of Grande Prairie survey, the highest median hydrocarbon levels were measured at Site #26 with values for THC, RHC and CH_4 of 6.1, 3.7 and 2.1 ppm, respectively. Median THC, RHC and CH_4 levels were 2.5, 0.5 and 1.9 ppm or less, respectively, at the other monitoring sites.

The median THC concentration based on data collected at all sites for the entire monitoring period was 2.0 ppm. Typical median THC concentrations at permanent monitoring stations located in Alberta range from 1.9 to 2.2 ppm. The median THC concentration from a similar monitoring survey conducted in the Caroline/Sundre area was 2.1 ppm. Median and maximum hydrocarbon concentrations at other locations in Alberta are presented in Tables A.3 and A.4 in Appendix A.



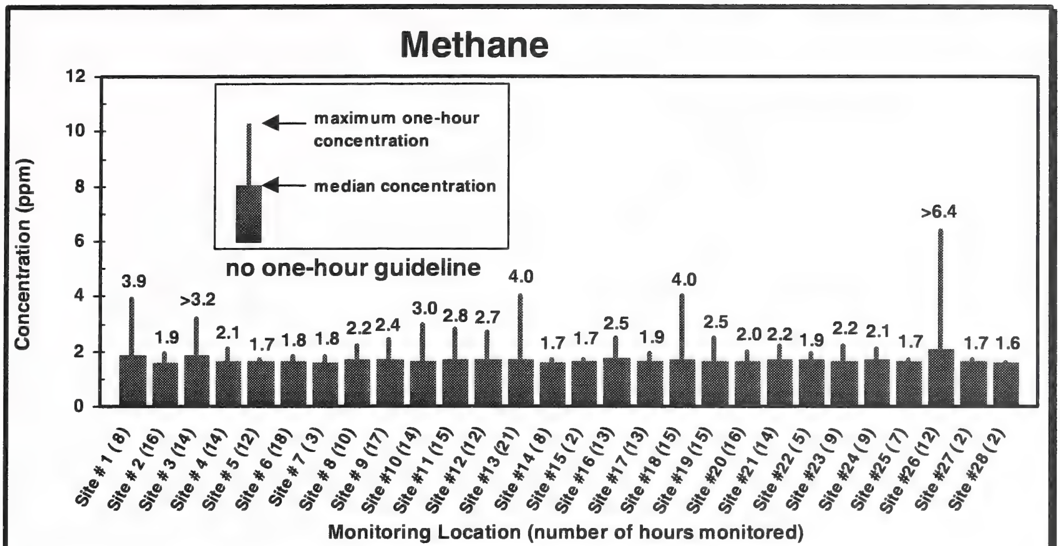
Note: Hydrocarbon concentrations at Site #3 and Site #26 exceeded the full range of the monitoring instrument for a portion of the monitoring period. **Total hydrocarbon concentrations in the background atmosphere range from 1.5 to 2.0 ppm.**

Figure 1.8 One-hour median and maximum concentrations for total hydrocarbons.



Note: Hydrocarbon concentrations at Site #3 and Site #26 exceeded the full range of the monitoring instrument for a portion of the monitoring period. **Reactive hydrocarbon concentrations in the background atmosphere are about 0.2 ppm.**

Figure 1.9 One-hour median and maximum concentrations for reactive hydrocarbons.



Note: Hydrocarbon concentrations at Site #3 and Site #26 exceeded the full range of the monitoring instrument for a portion of the monitoring period. **Methane concentrations in the background atmosphere range from 1.5 to 2.0 ppm.**

Figure 1.10 One-hour median and maximum concentrations for methane.

Particulates (TSP, PM_{10} and $PM_{2.5}$)

Maximum one-hour concentration recorded during survey	One-hour guideline
TSP = 2305 $\mu g/m^3$	no guideline
PM_{10} = 1287 $\mu g/m^3$	no guideline
$PM_{2.5}$ = 101 $\mu g/m^3$	no guideline

Air pollutants are not necessarily in a gaseous form. Tiny particles of solid material or liquid droplets, defined collectively as particulates, are also present in the atmosphere. Total suspended particulates (TSP) refer to all particles up to 500 microns in diameter (a human hair is about 100 microns in diameter) and are important primarily from a nuisance perspective. Particles less than 10 micrometres in diameter (PM_{10}) can be inhaled into the nose and throat while smaller particles, less than 2.5 micrometres in diameter ($PM_{2.5}$), can penetrate into the lungs. Sources of particulates include soil dust, road dust, agricultural dust (e.g., harvest), smoke from forest fires and recreational wood burning, vehicle exhaust emissions, brake and tire wear, and industrial emissions. Smaller particles ($PM_{2.5}$) originate in the atmosphere because of condensation and combustion from sources such as vehicle exhaust emissions, industrial emissions and wood burning. $PM_{2.5}$ are also formed as a result of reactions of gaseous chemicals in the air.

High particulate concentrations were recorded at several sites during the Grande Prairie survey. The major source of particulates at monitoring locations during this survey was likely road dust from traffic travelling on roads adjacent to the monitoring locations. TSP, PM_{10} and $PM_{2.5}$ were monitored during the County of Grande Prairie survey (see Figures 1.12 to 1.14).

The highest particulate concentrations were measured at Sites #10, #6, #19 and #1. Maximum one-hour average TSP levels were 2305, 1099, 891 and 200 µg/m^3, respectively at these four sites. PM_{10} levels were also high at these locations with maximum one-hour values of 1287, 669, 655 and 137 µg/m^3 recorded at Sites #10, #6, #19 and #1, respectively. The maximum $PM_{2.5}$ concentrations at these four sites were 101, 63, 60 and 16 µg/m^3, respectively. Maximum $PM_{2.5}$ concentrations were 9 µg/m^3 or less at all other monitoring sites. Elevated particulate readings during the County of Grande Prairie survey were caused by traffic along very dry and dusty gravel roads.

Based on median concentrations, the highest particulate levels were measured at Sites #19, #10, #16 and #20. Median TSP values were from 42 to 54 µg/m^3 at these four sites. Median PM_{10} levels ranged from 25 to 37 µg/m^3 and median $PM_{2.5}$ levels were 4 µg/m^3 or lower at these sites.

The median TSP, PM_{10} and $PM_{2.5}$ values for the entire County of Grande Prairie survey were 14, 9 and 2 µg/m^3, respectively. Median TSP levels during other mobile monitoring surveys in Alberta ranged from 4 µg/m^3 in the Caroline/Sundre area survey to 42 µg/m^3 in the Lethbridge area survey. Median PM_{10} levels ranged from 3 to 24 µg/m^3 in other mobile surveys and from 13 to 19 µg/m^3 in Edmonton and Calgary (based on 1999 data). Median $PM_{2.5}$ concentrations are typically 2 µg/m^3 or less at rural locations in Alberta and close to 10 µg/m^3 in Edmonton and Calgary.

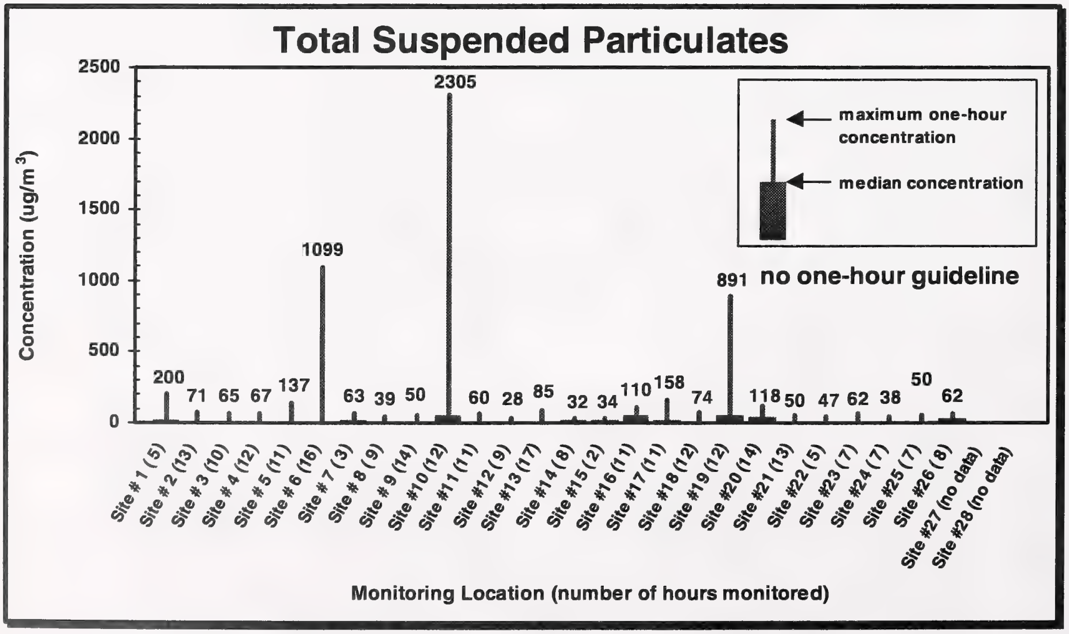


Figure 1.12 One-hour median and maximum concentrations for total suspended particulates.

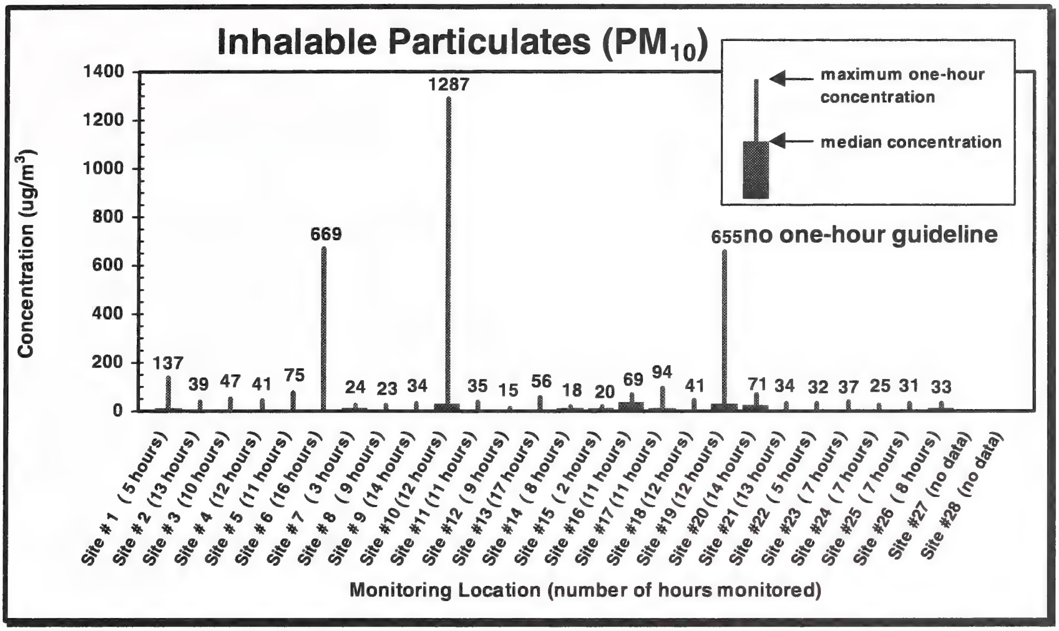


Figure 1.13 One-hour median and maximum concentrations for inhalable particulates.

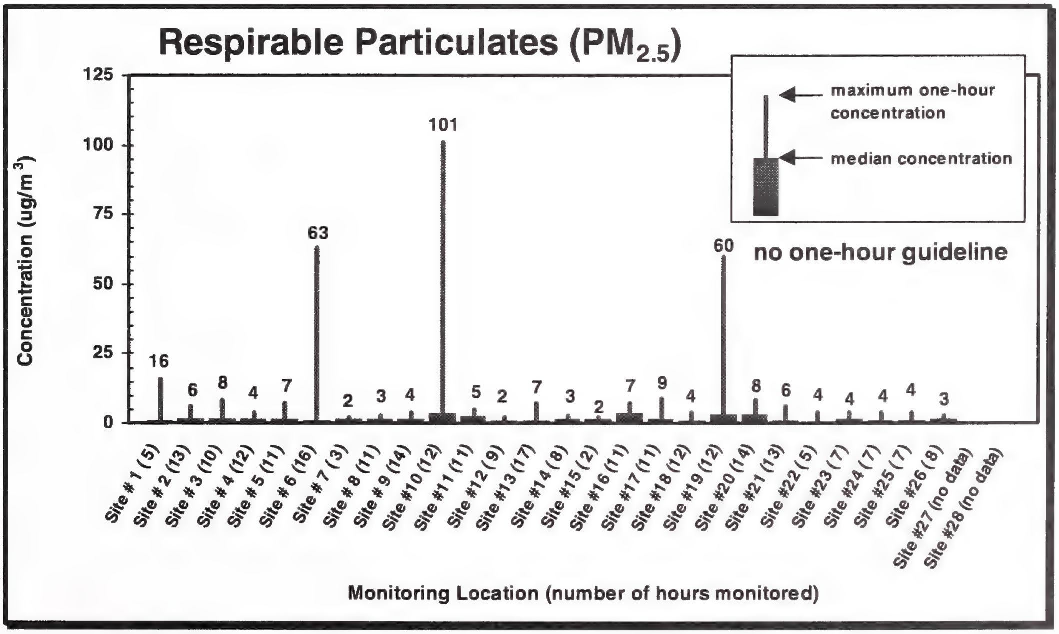


Figure 1.14 One-hour median and maximum concentrations for respirable particulates.

Ozone (O_3)

Maximum one-hour concentration recorded during survey	One-hour guideline
0.064 ppm	0.082 ppm (based on reduction of lung function and effects on tomatoes)

Ozone in the lower atmosphere is produced by: (1) the reaction of oxides of nitrogen and volatile organic compounds in the presence of sunlight, and (2) transport of O_3 from the upper atmosphere to ground level. Transport from the upper atmosphere is likely the dominant ozone producing process in the fall, winter and early spring seasons. O_3 concentrations are generally lower in urban centres due to the destruction of O_3 by nitric oxide.

O_3 concentrations in the County of Grande Prairie followed typical daily and seasonal variations that are observed at other locations in Alberta. The highest O_3 concentrations were generally measured in the afternoon of the spring and summer seasons. The maximum one-hour average O_3 concentration (0.064 ppm) was recorded from 12:25 p.m. to 1:25 p.m. on June 18, 1999 at Site #9 (see Figure 1.15). This maximum value is 78% of the one-hour guideline for O_3. Maximum one-hour O_3 concentrations in the winter, spring, summer and fall survey periods were 0.043, 0.056, 0.064 and 0.040 ppm, respectively.

The median O_3 concentration in the County of Grande Prairie ranged from 0.025 ppm at Site #1 to 0.046 ppm at Site #25. Lower median O_3 concentrations were observed at sites that were monitored more frequently in the morning and higher median levels were measured at sites that were monitored in the afternoon. Higher O_3 levels were observed in the afternoon because of more sunlight, warmer temperatures and more vertical mixing of the atmosphere. All of these factors lead to higher levels of background O_3 at ground level.

The median O_3 concentration for the entire County of Grande Prairie survey was 0.035 ppm. Typical median O_3 levels at rural locations in Alberta range from about 0.030 to 0.045 ppm based on 1999 data. The median O_3 concentration at the Beaverlodge station in 1999 was 0.031 ppm. O_3 levels in large cities are generally much lower than rural areas. Median O_3 levels at permanent monitoring stations in Edmonton and Calgary in 1999 ranged from 0.013 to 0.023 ppm. Lower O_3 levels in urban centres are due to the destruction of natural O_3 by nitric oxide emitted by vehicles.

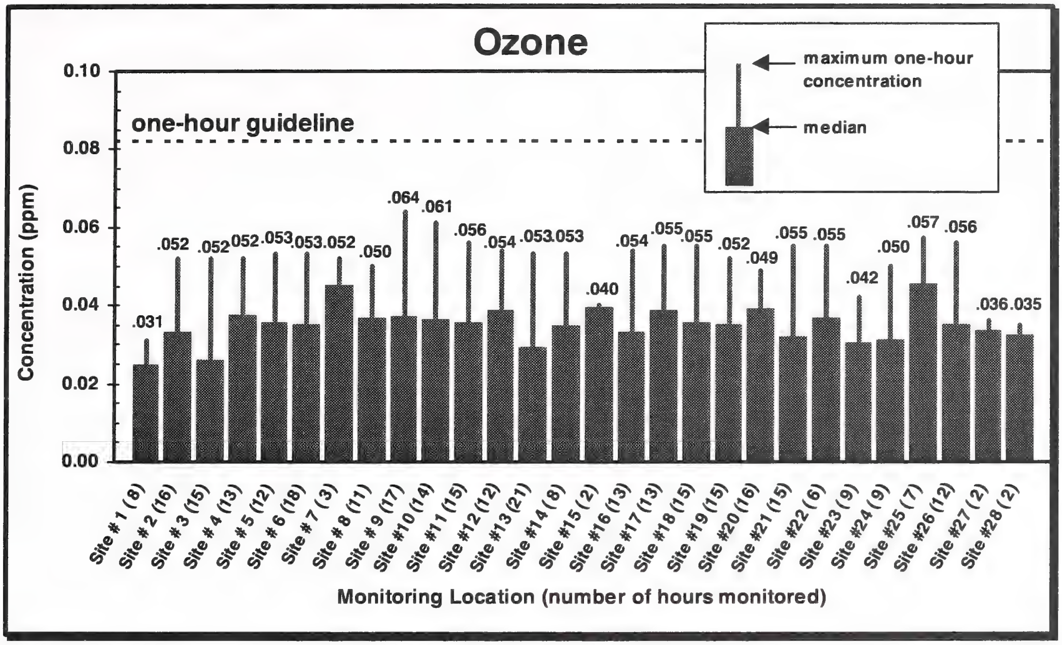


Figure 1.15 One-hour median and maximum concentrations for ozone.

Oxides of Nitrogen (NO_2, NO and NO_x)

Maximum one-hour concentration recorded during survey	One-hour guideline
NO_2 = 0.061 ppm	0.212 ppm (based on odour perception)
NO = 0.087 ppm	no guideline
NO_x = 0.103 ppm	no guideline

Oxides of nitrogen (NO_x) are the total of nitrogen dioxide (NO_2) and nitric oxide (NO). During high temperature combustion - as in the burning of natural gas, coal, oil and gasoline - atmospheric nitrogen may combine with molecular oxygen to form NO. NO is colourless and odourless. Most NO in the ambient air is oxidized to form NO_2. NO_2 is a reddish-brown gas with a pungent odour. The major source of oxides of nitrogen in urban areas is vehicle exhaust emissions. Processes associated with the oil and gas industry also emit oxides of nitrogen into the atmosphere.

As shown in Figure 1.16, NO_2 levels were below Alberta's one-hour guideline at all monitoring locations during the County of Grande Prairie survey. The maximum NO_2 concentration was recorded at Site #9 on October 15, 1999 from 2:58 p.m. to 3:59 p.m. (0.061 ppm). The NO_2 concentration recorded at this time is 29% of the one-hour guideline. NO_2 at this location was likely caused by compressor stack emissions from a nearby gas plant. The second highest NO_2 concentration (0.050 ppm) was measured at Site #13 on June 24, 1999 (12:09 p.m. to 1:15 p.m.) and may have been due to truck traffic near the monitoring site. The next highest one-hour value (0.044 ppm) was detected at Site # 1 on October 26, 1999 (4:24 p.m. to 5:24 p.m.). The likely sources of oxides of nitrogen at Site #1 were dehydrators or compressors from a nearby plant site.

Maximum one-hour NO_2 concentrations during other air quality surveys conducted by Alberta Environment ranged from 0.013 to 0.080 ppm. Based on data collected in 1999, maximum one-hour NO_2 concentrations in Edmonton and Calgary range from 0.069 to 0.127 ppm due to the influence of vehicle exhaust emissions. The maximum NO_2 value measured at the Beaverlodge station in 1999 was 0.035 ppm.

The overall median NO_2 concentration at all sites was 0.002 ppm. Median NO_2 levels at rural locations in Alberta generally range from 0.001 to 0.004 ppm (based on 1999 data). In Edmonton and Calgary, typical median NO_2 levels range from 0.013 to 0.026 ppm. The major source of oxides of nitrogen at urban locations is vehicle exhaust emissions. The median NO_2 concentration in 1999 at the Beaverlodge station was 0.003 ppm.

The primary source of oxides of nitrogen in the County of Grande Prairie survey was vehicle exhaust emissions and emissions from processes related to the oil and gas industry. However, as mentioned earlier, NO_2 concentrations in the County of Grande Prairie survey were low compared to the one-hour guideline.

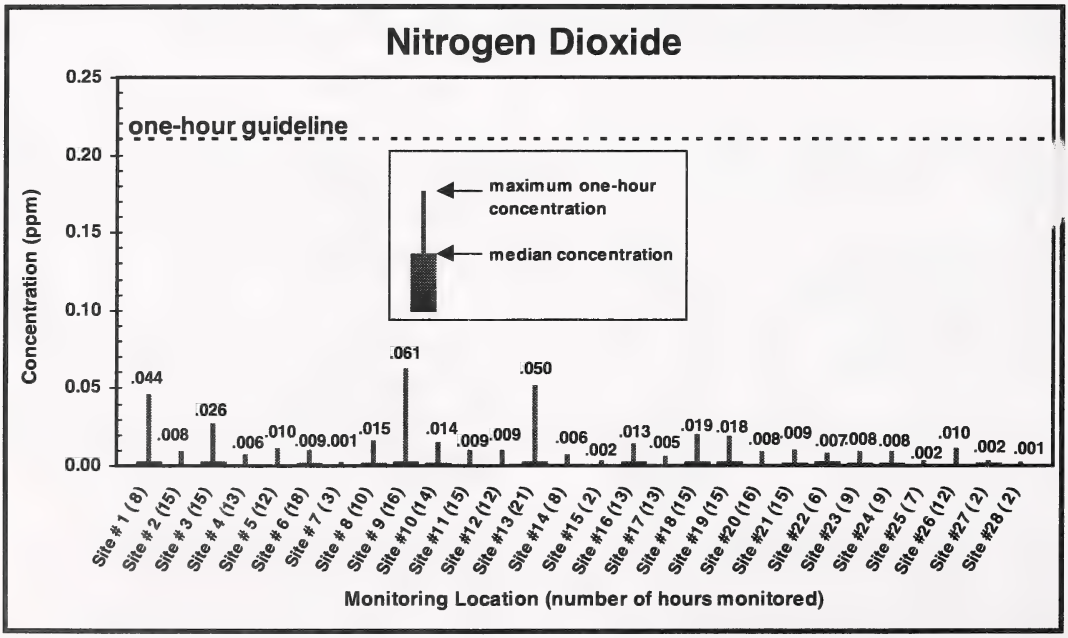


Figure 1.16 One-hour median and maximum concentrations for nitrogen dioxide.

Carbon Monoxide (CO)

Maximum one-hour concentration recorded during survey	One-hour guideline
1.0 ppm	13.0 ppm (based on the oxygen-carrying capacity of blood)

Carbon monoxide (CO) is a colourless, odourless gas emitted into the atmosphere primarily by motor vehicles. Minor sources include fireplaces, industry, aircraft and natural gas combustion. The major source of carbon monoxide at urban locations is vehicle exhaust emissions.

CO values were low during the entire County of Grande Prairie survey. The maximum one-hour concentration of 1.0 ppm was recorded at Site #26 on April 19, 1999 from 11:06 a.m. to 12:22 p.m. This maximum one-hour concentration is 8% of the one-hour guideline for CO. Elevated hydrocarbon levels were also detected at this time (see previous section on hydrocarbons). Loading and unloading of petroleum tanker trucks at a nearby oil battery were noted by the MAML operator during this time period. Maximum one-hour CO concentrations were 0.7 ppm or lower at the other monitoring sites during this survey.

Median CO levels ranged from 0.1 to 0.3 ppm at all monitoring sites. The overall median concentration in the County of Grande Prairie survey was 0.2 ppm. Median CO concentrations at other mobile surveys in Alberta range from 0.2 to 0.4 ppm. At urban locations such as Edmonton and Calgary, typical median CO levels range from 0.3 to 0.6 ppm (based on 1999 data). The major source of CO at urban locations is vehicle exhaust emissions. CO is also emitted by combustion processes associated with the oil and gas industry.

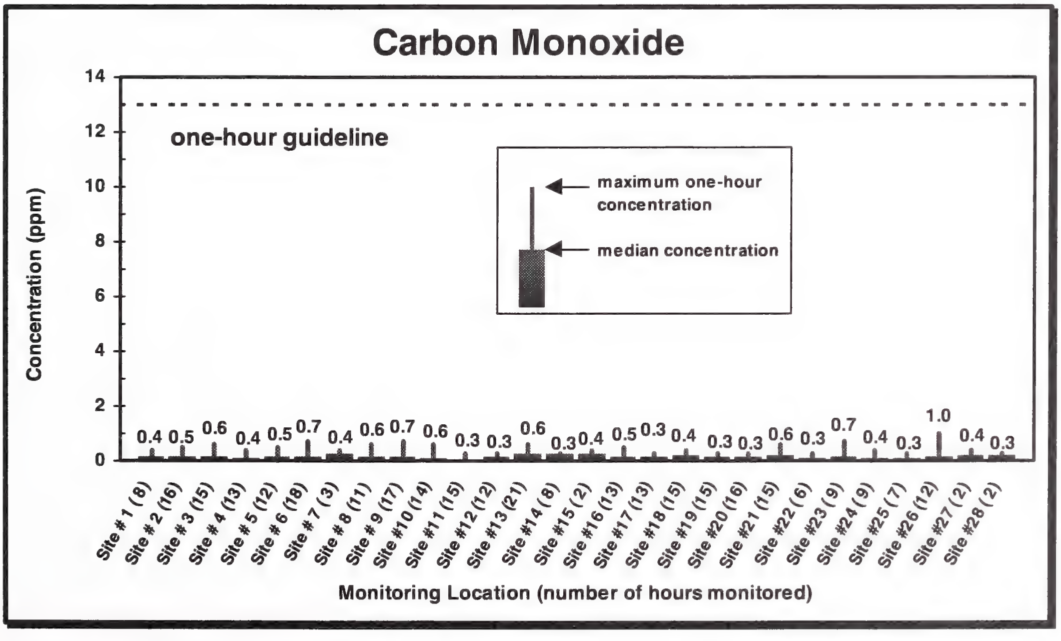


Figure 1.17 One-hour median and maximum concentrations for carbon monoxide.

Polycyclic Aromatic Hydrocarbons (PAHs)

Maximum one-hour concentration recorded during survey	One-hour guideline
35 μg/m^3	no guideline

Polycyclic aromatic hydrocarbons (PAHs) are a class of chemicals that are usually contained in soot and smoke. There are more than 100 different PAHs with varying levels of toxicity. They are formed during the incomplete combustion of gasoline, diesel, oil, coal, wood, garbage or other organic substances. Tobacco smoke and charbroiled meats are common sources of PAHs. Other outdoor PAH sources include vehicle exhaust emissions, wood smoke from fireplaces, smoke from forest fires and industrial facilities. PAHs occur in the atmosphere in the vapour phase or attached to dust particles. The PAH monitoring instrument aboard the MAML will analyze only particulate bound PAHs.

The highest one-hour average PAH concentration was recorded at Site #27 from 11:24 a.m. to 12:24 p.m. on October 17 (35 ng/m^3 or nanograms per cubic metre). A well test was being conducted near this site at this time. The PAHs measured at this site were likely due to flaring that was undertaken during the well test (see Figure 1.18). The MAML operator also noted a diesel type odour from recovered oil associated with the well test. The maximum PAH concentration measured at Site #27 (35 ng/m^3) was similar to maximum one-hour PAH levels that were measured during other mobile air monitoring surveys conducted by the MAML in the Lethbridge area and Medicine Hat (11 to 35 ng/m^3). A Carbotrap tube was set out at Site #27 to monitor hydrocarbons downwind of the well test (see results in Part 2 of this report).

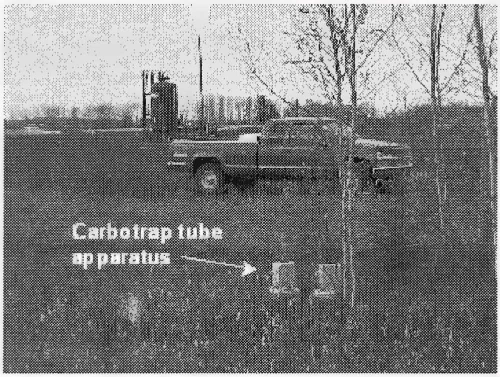


Figure 1.18 Flare associated with well test at Site #27.

The overall median PAH concentration at all sites in the County of Grande Prairie survey was 2 ng/m^3. This value is the same as the median PAH concentration measured in an air quality survey of the Lethbridge area. Median PAH levels measured during air quality surveys in the cities of Lethbridge and Medicine Hat were 3 and 5 ng/m^3, respectively. PAHs are not routinely monitored on an hourly basis at Alberta Environment permanent monitoring stations.

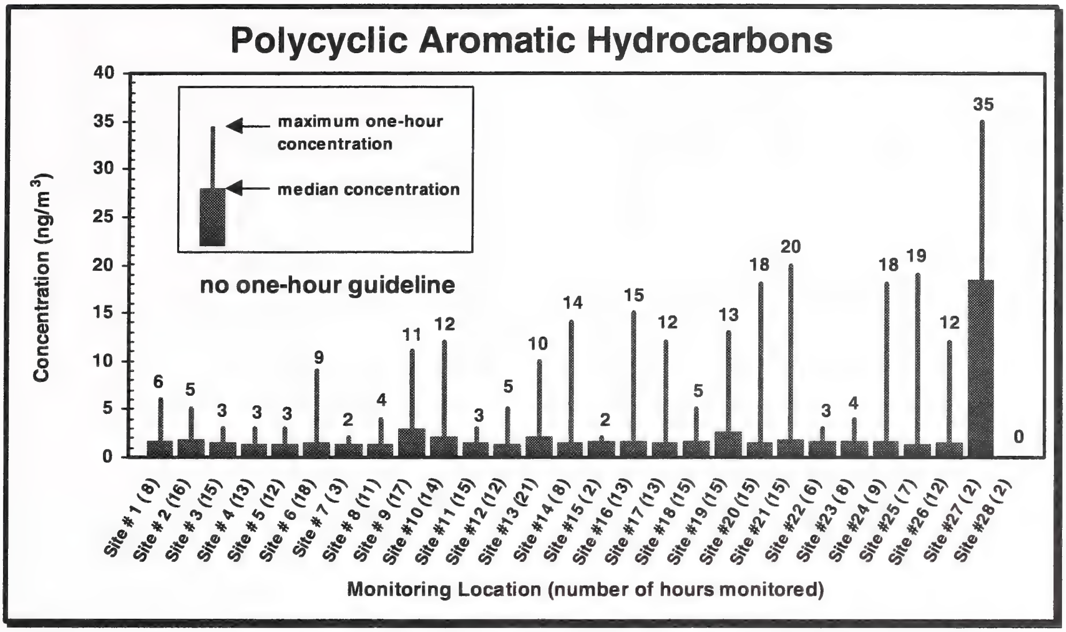


Figure 1.19 One-hour median and maximum concentrations for polycyclic aromatic hydrocarbons.

Ammonia (NH_3)

Maximum one-hour concentration recorded during survey	One-hour guideline
0.030 ppm	2.0 ppm (based on odour perception)

Ammonia is a colourless gas with the well-known pungent odour found in household cleaners. NH_3 is produced both by natural and man-made sources. Some natural sources of NH_3 include the decay of plant material and animal waste. A small portion is also released during respiration. In Alberta, the fertilizer industry is the main industrial source of NH_3. The industry produces synthetic NH_3 for either direct application to soil as a fertilizer, or as a raw material for use in the production of other high nitrogen fertilizer products. The other major source of NH_3 is commercial feedlots, specifically from their large amounts of animal waste.

Ammonia levels in the County of Grande Prairie survey were very low at all monitoring sites. The highest one-hour average NH_3 concentration detected during the survey (0.030 ppm) was measured at Site #13 from 12:09 p.m. to 1:15 p.m. on June 24, 1999. The ammonia concentration measured at this time is less than 2% of the one-hour guideline for ammonia. Ammonia was also detected at low levels at Sites #1, #3, #9 and #19 with maximum one-hour values ranging from 0.012 to 0.022 ppm. Ammonia levels measured in the County of Grande Prairie survey would likely not be detected as an odour.

Median ammonia levels at all sites ranged from 0.001 to 0.003 ppm. The overall median level for the entire survey was 0.001 ppm. Median ammonia concentrations at other mobile air quality surveys conducted in Alberta ranged from 0.003 ppm in the City of Medicine Hat to 0.075 ppm in the Lethbridge area. The median ammonia concentration at the Fort Saskatchewan permanent monitoring station was 0.002 ppm, based on 1999 data. NH_3 is not continuously monitored by Alberta Environment at any other monitoring stations.

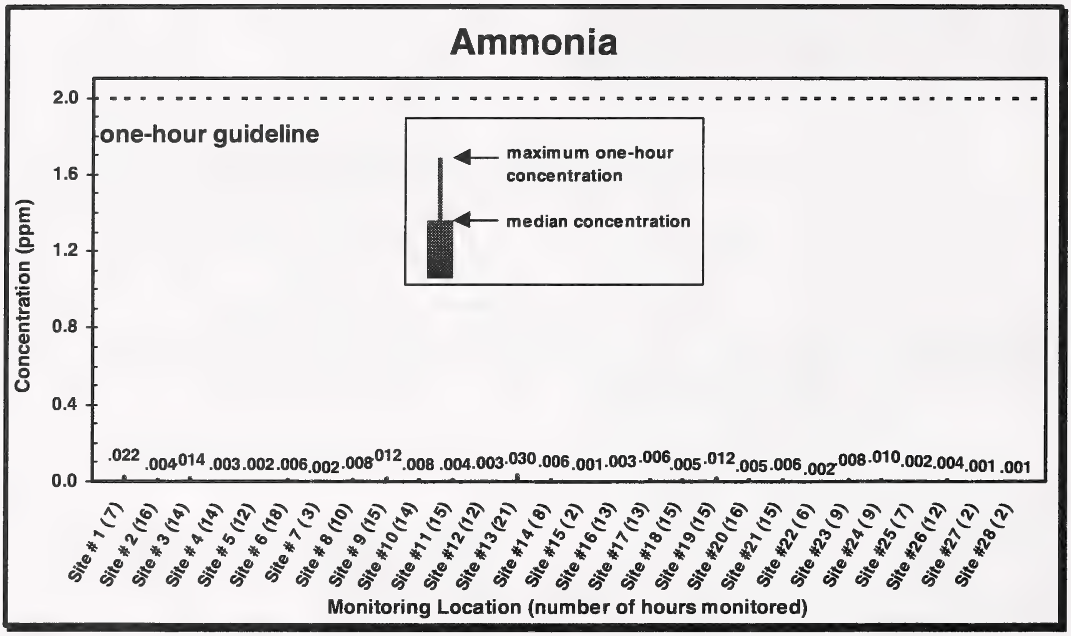


Figure 1.20 One-hour median and maximum concentrations for ammonia.

Part 2: Monitoring for Volatile Organic Compounds

Volatile organic compounds (VOCs) include a large group of chemicals containing carbon and hydrogen atoms that can react quickly to form other chemicals in atmosphere. They are important because they can present a health risk to humans, animals and vegetation. VOCs can also react with oxides of nitrogen (NO_x) to form ozone (O_3), a health hazard and major contributor to smog.

Major sources of VOCs in Alberta include automobile emissions, gasoline marketing and storage tanks, petroleum and chemical industries, and natural gas combustion. Other sources of VOCs include the evaporation of solvents as well as leaking valves, flanges, pumps and compressors at industrial facilities. VOCs are also contained in incinerator and flare stack emissions associated with the oil and gas industry. The VOCs monitored in the County of Grande Prairie survey were benzene, toluene, ethylbenzene and xylenes, often referred to as BTEX compounds. Concentrations of BTEX compounds measured in the County of Grande Prairie survey are presented in Appendix B of this report.

Benzene

Benzene is a colourless gas with a sweet odour. Exposure to high concentrations for a prolonged period of time is known to cause cancer. Benzene is recognized as a chemical "concluded to be toxic" on the Environment Canada First Priority Substances List (PSL1).[3] It is ranked fifth on the U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry (ATSDR) list of hazardous substances.[4] Major sources of benzene include vehicle exhaust, refuelling operations and industrial emissions. Common indoor sources of benzene include cigarette smoke, glues, paint, furniture wax and detergents.

Toluene

Toluene is a colourless gas with a distinctive sweet and pungent odour. It is produced during activities such as gas processing and contained in paints, paint thinners, fingernail polish, lacquers and adhesives. Vehicle exhaust is also a major source of toluene. Toluene has been recognized on the PSL1 list as a chemical “not concluded to be toxic”. Toluene is ranked 62nd on the ATSDR list of hazardous substances.

Ethylbenzene

Ethylbenzene is a colourless gas with a distinctive aromatic odour. It is used in the manufacturing of styrene, plastics, synthetic rubber and latex products. Ethylbenzene is also used as a solvent and is a component of gasoline. The toxicity of ethylbenzene is being considered on the Environment Canada Second Priority Substances List (PSL2).[3] Ethylbenzene is ranked 87th on the ATSDR list of hazardous substances.

Xylenes

Total xylenes include m-, p- and o-xylenes. Xylenes are colourless and have a sweet odour when emitted into the atmosphere. Xylenes are used in solvents, cleaning agents, paint thinner, paints and varnishes. Gasoline and forest fires also produce xylenes. Xylenes are recognized as chemicals "not concluded to be toxic" on the PSL1 list. Xylenes are ranked 48th on the ATSDR list of hazardous substances.

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[3] Environment Canada. 1995. *Report of the Ministers' Expert Advisory Panel on the second priority substances list under the Canadian Environmental Protection Act (CEPA).* PSL2 Secretariat, Environment Canada, Hull, Quebec.

[4] Agency for Toxic Substances and Disease Registry. *1999 CERCLA List of Priority Hazardous Substances.* http://www.atsdr.cdc.gov/99list.html.

Monitoring Method

A total of 80 VOC samples were collected at 21 locations during the County of Grande Prairie survey (see map on page six). These samples were collected for one to 24-hour time periods based on odours or other air quality concerns identified by the MAML operators.

Air samples were collected using Carbotrap tubes to further identify different types of VOCs. This active method was used in this survey because:

(1) it uses a pump that requires only battery power,
(2) it can sample at locations where the MAML cannot access, and
(3) it is relatively inexpensive and easy to operate in the field.

The majority of Carbotrap tube samples were collected for one-hour (48 samples) or 24-hour (26 samples) time periods. One-hour samples were collected so that a direct comparison to Alberta's one-hour guideline for benzene was possible. Samples were collected for 24-hour time periods to allow comparison to the U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels for acute exposures. Acute exposure is defined by the ATSDR as exposures over a one to 14-day time period (ATSDR, 2000). BTEX concentrations in one- and 24-hour samples are also compared to Ontario's Point of Impingement Limits and Air Quality Standards where appropriate. The 24-hour samples collected at the Agriculture and Agri-Food Canada Research Farm located near Beaverlodge (Site #2) were used to determine regional background levels for BTEX compounds.

The Carbotrap 400 tube (see Figure 2.1 and Figure 2.2) consists of a glass tube 10.6 cm long with a 0.4 cm inside diameter coated internally with an adsorbent media called Carbotrap. Air is passed through this tube at a low flow rate (about 10 to 100 cm^3/min), depending on the defined period of time (e.g. one hour). The Carbotrap is specifically formulated to adsorb a number of different hydrocarbon species. The tube undergoes laboratory analysis by gas chromatography and mass spectroscopy to quantify ambient concentrations of the hydrocarbons of interest. This monitoring method conforms to the U.S. Environmental Protection Agency (EPA) Compendium Method TO-17.[5] In this study, the Carbotrap tubes were analyzed for benzene, toluene, ethylbenzene and xylenes.

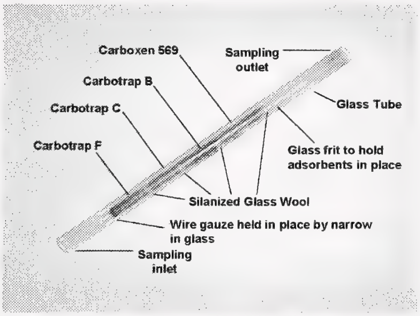

Figure 2.1 Diagram of Carbotrap 400 adsorbent tube.

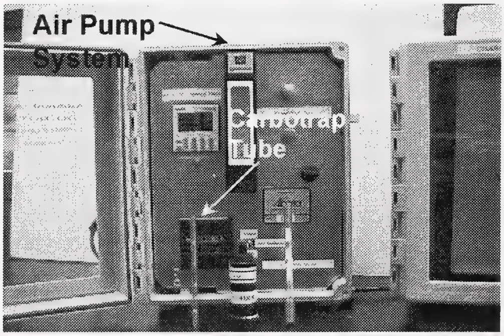

Figure 2.2 Carbotrap tube and air pump system.

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[5] U.S. Environmental Protection Agency. *1999. Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air: Second Edition. Compendium Method TO-17: Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes.* EPA/625/R-96/010b.

Table 2.1 Air Quality Guidelines, Point of Impingement Limits, Air Quality Standards and Minimal Risk Levels for BTEX compounds (μg/m^3).

	Benzene	Toluene	Ethylbenzene	Xylenes
Alberta Ambient Air Quality Guideline (one-hour)	30	n/a	n/a	n/a
Ontario Point of Impingement Limit (half-hour)	n/a	2000	n/a	2300
Ontario Air Quality Standard (one-hour)	n/a	n/a	4000	n/a
Ontario Air Quality Standard (24-hours)	n/a	2000	n/a	2300
ATDSR Minimal Risk Level for Acute Exposures (one to 14 days)	160	15,000	n/a	4340
Odour Threshold (from Ruth, 1986)	4500	8025	8700	348

Air Quality Guidelines

The Alberta Ambient Air Quality Guideline for one-hour benzene concentrations is 30 μg/m^3 (micrograms of benzene per cubic meter of air). This guideline was developed based on the eight-hour occupational exposure limit divided by a safety factor of 100. Therefore, benzene concentrations higher than the Alberta one-hour ambient guideline will not necessarily cause negative effects to human or environmental health. This guideline is intended to provide an early warning of potential health impacts if these levels persist over an extended time period.

The ATSDR Minimal Risk Level for acute exposure (one to 14 days) to benzene is 160 μg/m^3. The Minimal Risk Level is "an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure".[6] Benzene can be detected as an odour at concentrations of about 4500 μg/m^3.[7]

Alberta does not have Ambient Air Quality Guidelines for toluene, ethylbenzene or xylenes. However, Ontario has Air Quality Point of Impingement Limits for toluene and xylenes of 2000 and 2300 μg/m^3, respectively, as a half-hour concentration. The Ontario 24-hour Air Quality Standards for toluene and xylenes are also 2000 and 2300 μg/m^3, respectively. Ontario has a one-hour Air Quality Standard for ethylbenzene of 4000 μg/m^3.[8]

The ATSDR Minimal Risk Levels for acute exposure (one to 14-days) to toluene and xylenes are 15,000 and 4340 μg/m^3, respectively. The ATSDR does not have a Minimal Risk Level for acute exposures to ethylbenzene. The odour thresholds for toluene, ethylbenzene, and xylenes are 8025, 8700, and 348 μg/m^3, respectively.

Air Quality Guidelines, Point of Impingement Limits, Air Quality Standards and Minimal Risk Levels for BTEX compounds are shown in Table 2.1 (above).

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[6] Agency for Toxic Substances and Disease Registry. 2000. Minimal Risk Levels (MRLs) for hazardous substances. http://www.atsdr.cdc.gov/mrls.html. February 2000.

[7] Ruth, J.H. 1986. *Odor thresholds and irritation levels of several chemical substances: a review.* Am. Ind. Hyg. Assoc. J 47: pp. A-142 to A-151.

[8] Ontario Ministry of the Environment and Energy. 1994. *Summary of Point of Impingement Standards, Ambient Air Quality Criteria (AAQCs), and Approvals Screening Levels (ASLs).* Standards Development Branch.

Results

Based on 80 samples collected at twenty-one locations in the County of Grande Prairie, maximum concentrations of toluene, ethylbenzene and xylenes were below Point of Impingement Limits and Air Quality Standards established in Ontario. Levels of all BTEX compounds were also lower than their respective ATSDR Minimal Risk Levels and odour thresholds. However, benzene concentrations were higher than Alberta's one-hour guideline in five of the 80 samples (see Table 2.2). These five samples were collected at Site #1 (2 km southwest of Elmworth), Site #3 (2.5 km southeast of Goodfare), and Site #19 (10 km south-southwest of La Glace).

At Site #1, a sample with a benzene concentration of 57 $\mu g/m^3$ was collected on June 17 from 8:15 a.m. to 9:15 a.m. This sample was taken about 10m from the facility fence line (see Figures 2.3 and 2.4). The one-hour ambient guideline for benzene is 30 $\mu g/m^3$. The MAML operator noted slight odours from the plant during this time period. Toluene (63 $\mu g/m^3$), ethylbenzene (3 $\mu g/m^3$) and xylene (17 $\mu g/m^3$) levels in this sample were below Ontario's Point of Impingement Limits of 2000, 4000 and 2300 $\mu g/m^3$, respectively. The exact cause of this elevated benzene concentration could not be determined but was likely a source on the adjacent plant site.

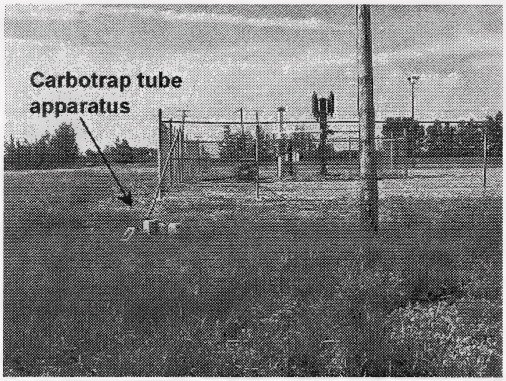


Figure 2.3 Carbotrap tube apparatus located near Site #1 (looking south – June 17, 1999).

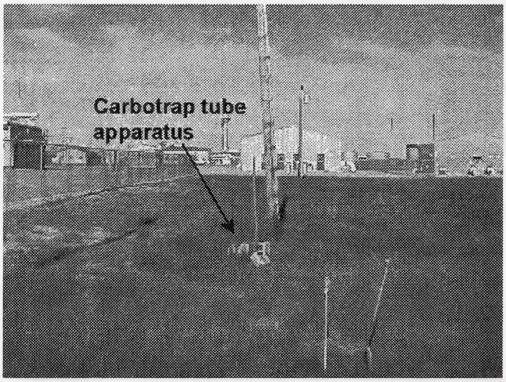


Figure 2.4 Carbotrap tube apparatus located near Site #1 (looking west – June 17, 1999).

Table 2.2 Exceedances of the one-hour guideline for benzene.

Site #	Source of Exceedance	Concentration (ug/m^3)	Date and Time	Comments
Site #1	Canadian Hunter Elmworth gas plant	57	Jun. 17, 1999 (8:15 a.m. to 9:15 a.m.)	Weak odours from plant. Source unknown.
Site #3	Crestar Energy Goodfare gas plant and battery station	56	Jun. 25, 1999 (8:51 a.m. to 9:51 a.m.)	Sample at plant fenceline. 25-30 m from road. Wind light NE.
Site #3	Crestar Energy Goodfare gas plant and battery station	47	Oct. 15, 1999 (8:33 a.m. to 9:33 a.m.)	Odour from four foot high vent pipe 44 m away on east edge of compound.
Site #3	Crestar Energy Goodfare gas plant and battery station	49	Oct. 26, 1999 (8:24 a.m. to 9:24 a.m.)	Downwind of four foot pipe.
Site #19	CCS La Glace oilfield waste disposal facility	32	Jun. 15, 1999 (3:16 p.m. to 4:15 p.m.)	Strong odours downwind from CCS La Glace facility. Plant operator said that odours may be from contaminated soils on site.
One-hour Guideline for Benzene		30		

At Site #3, three samples had benzene concentrations greater than Alberta's one-hour guideline. These samples were collected on June 25, 1999 (8:51 a.m. to 9:51 a.m.), October 15, 1999 (8:33 a.m. to 9:33 a.m.) and October 26, 1999 (8:24 a.m. to 9:24 a.m.). Benzene concentrations measured in these samples were 56, 47 and 49 $\mu g/m^3$, respectively, compared to Alberta's one-hour guideline of 30 $\mu g/m^3$. Two other samples collected at this site yielded benzene concentrations of 28 $\mu g/m^3$ (June 20, 1999) and 27 $\mu g/m^3$ (October 23, 1999), just below the one-hour guideline. The maximum toluene, ethylbenzene and xylene levels measured in these air samples were 199, 13 and 115 $\mu g/m^3$, respectively. These values are well below Ontario's Point of Impingement Limits. Elevated benzene values at this location may have been associated with odours noted by the MAML operator from a vent pipe on the east edge of the compound. The air samples collected by the Carbotrap tube were within 10m from the facility fence line (see Figure 2.5).

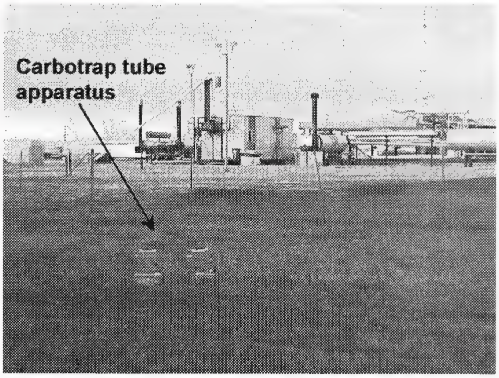


Figure 2.5 Carbotrap tube apparatus located near Site #3 (October 15, 1999).

The one-hour guideline for benzene was also exceeded at Site #19 from 3:16 p.m. to 4:15 p.m. on June 15, 1999. The benzene concentration recorded in this air sample was 32 $\mu g/m^3$, just slightly higher than the one-hour guideline. The MAML operator noted strong odours while this sample was being collected. A possible cause of these odours was contaminated soil from the adjacent facility (CCS La Glace oilfield waste disposal facility). Toluene, ethylbenzene and xylene levels in this sample (110, 13 and 110 $\mu g/m^3$, respectively) were much lower than Ontario's point impingement standards. This sample was collected about 10m from the fence line of the facility.

The highest benzene concentration measured in air samples collected for a 24-hour time period was 7.8 $\mu g/m^3$, measured at Site #11. This value is well below the ATSDR Minimal Risk Level for acute exposure durations (one to 14 days) of 160 $\mu g/m^3$. The highest 24-hour toluene (13 $\mu g/m^3$), ethylbenzene (10 $\mu g/m^3$) and xylene (30 $\mu g/m^3$) concentrations were measured at Site #19 from 3:15 p.m. on June 15 to 2:30 p.m. on June 16, 1999. These 24-hour toluene and xylene concentrations are much lower than the ATSDR Minimal Risk Levels for acute exposure (one to 14 days) of 15,000 $\mu g/m^3$ and 4340 $\mu g/m^3$, respectively. Ethylbenzene does not have a Minimal Risk Level for acute exposures.

Median 24-hour BTEX levels in the County of Grande Prairie survey were lower than those typically measured in Edmonton and Calgary (see Table 2.3 on page 26). The median benzene concentration from 24-hour samples collected in the County of Grande Prairie survey was 0.4 $\mu g/m^3$ compared to median values ranging from 1.3 to 1.6 $\mu g/m^3$ at Edmonton and Calgary monitoring stations. Median toluene, ethylbenzene and xylene concentrations from 24-hour samples collected in the County of Grande Prairie survey were 0.6, 0.1 and 0.3 $\mu g/m^3$, respectively. Median concentrations of these compounds in 1999 from 24-hour samples taken in Edmonton and Calgary ranged from 3.1 to 4.2 µg/m^3 for toluene, 0.6 to 1.0 µg/m^3 for ethylbenzene and 3.0 to 5.2 µg/m^3 for xylenes. BTEX concentrations from Edmonton and Calgary are based on air samples collected using the SUMMA canister monitoring method. This method involves collecting air samples using a six-litre stainless steel canister, every sixth day (according to the National Air Pollution Surveillance network schedule) for a 24-hour time period.

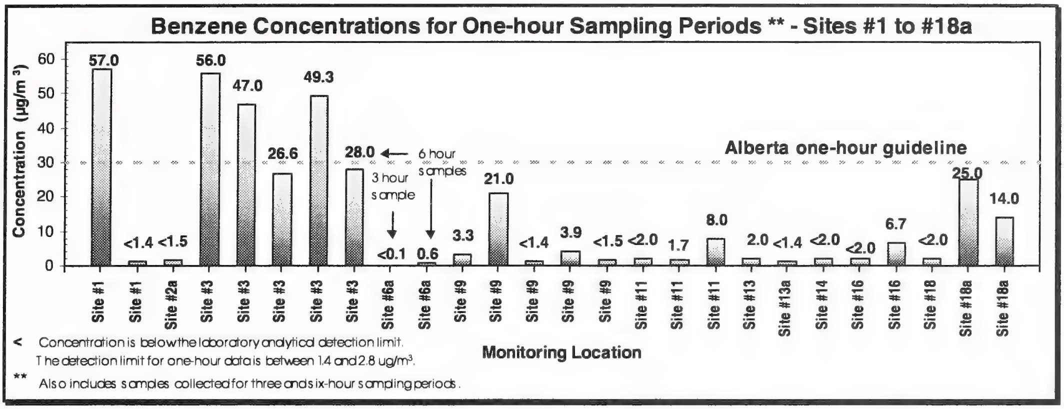
Regional background levels of benzene from Site #2 (the Agriculture and Agri-Food Canada Research Farm located near Beaverlodge) ranged from less than the analytical detection limit (less than 0.07 µg/m^3) to 0.6 µg/m^3. Background levels of toluene, ethylbenzene and xylenes ranged from less than the analytical detection limit to 1.5, 0.3 and 1.9 µg/m^3, respectively. Median regional background levels of benzene and toluene were 0.3 and 0.2 µg/m^3, respectively. Median regional background ethylbenzene and xylenes values were less than the analytical detection limit. These background levels are based on 12 air samples collected at Site #2.

All air samples with benzene concentrations greater than Alberta's one-hour guideline were collected close to a potential benzene source (e.g. within 10m of the fence line). Ambient benzene concentrations at distances further downwind of sources in the County of Grande Prairie survey were low compared to the ambient guideline. Therefore, it would be expected that benzene concentrations at the closest residence to these facilities would be below the ambient guideline. As mentioned earlier, the one-hour guideline for benzene is intended to provide an early warning of potential health impacts if elevated levels persist over an extended time period. It is also important to note that Alberta's one-hour benzene guideline is 100 times lower than the occupational exposure limit for an eight-hour exposure period. Based on the results of the 24-hour samples collected near these facilities, it appears that elevated benzene concentrations (greater than 30 µg/m^3) did not persist over extended time periods.

Table 2.3 Median BTEX concentrations from 24-hour samples collected in the County of Grande Prairie and in Edmonton and Calgary (µg/m^3).

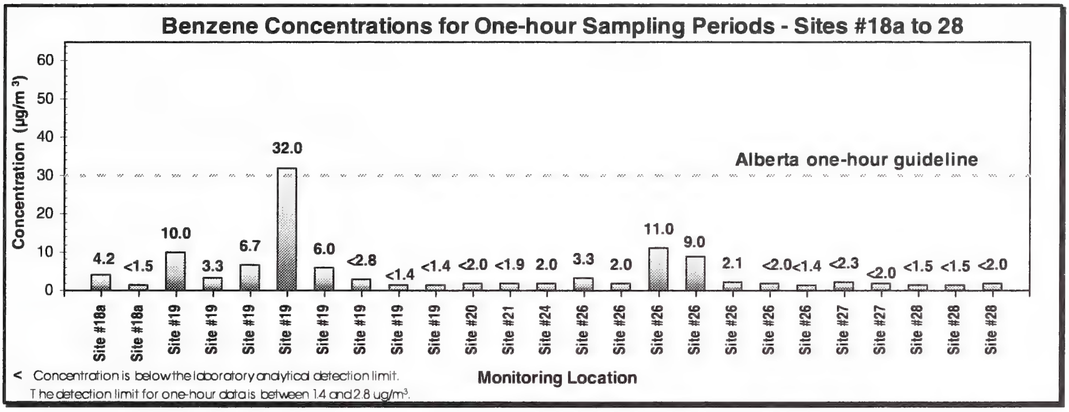
Location	Benzene	Toluene	Ethylbenzene	Xylenes
County of Grande Prairie (24-hour samples)	0.4	0.6	0.1	0.3
Edmonton Central*	1.6	4.2	0.9	4.6
Edmonton East*	1.3	3.1	0.6	3.0
Calgary Central*	1.4	4.2	1.0	5.2

- Medians at Edmonton and Calgary are based on 1999 data. Based on 24-hour samples collected every sixth day in accordance with the National Air Pollution Surveillance (NAPS) schedule.

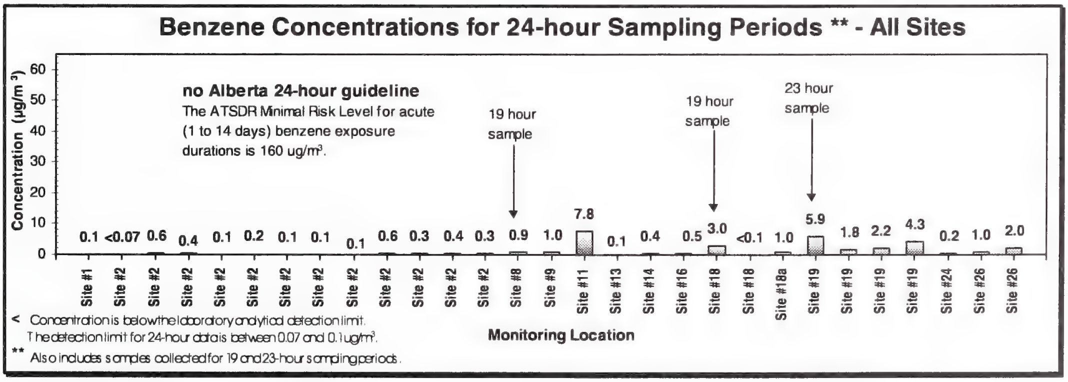

Benzene Concentrations for One-hour Sampling Periods ** - Sites #1 to #18a

< Concentration is below the laboratory analytical detection limit.
The detection limit for one-hour data is between 1.4 and 2.8 ug/m³.

** Also includes samples collected for three and six-hour sampling periods.


Benzene Concentrations for One-hour Sampling Periods - Sites #18a to 28

< Concentration is below the laboratory analytical detection limit.
The detection limit for one-hour data is between 1.4 and 2.8 ug/m³.

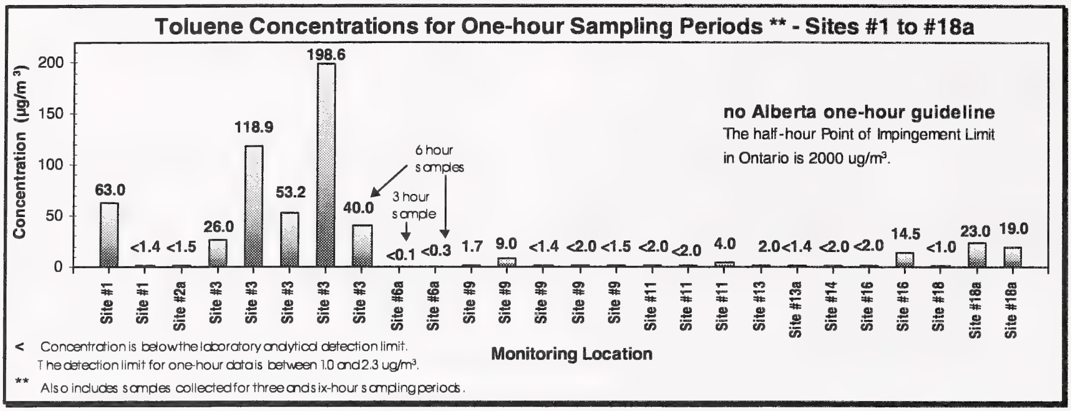

Benzene Concentrations for 24-hour Sampling Periods ** - All Sites

no Alberta 24-hour guideline
The ATSDR Minimal Risk Level for acute (1 to 14 days) benzene exposure durations is 160 ug/m³.

< Concentration is below the laboratory analytical detection limit.
The detection limit for 24-hour data is between 0.07 and 0.1 ug/m³.

** Also includes samples collected for 19 and 23-hour sampling periods.

Figure 2.6 Benzene concentrations in the County of Grande Prairie survey.

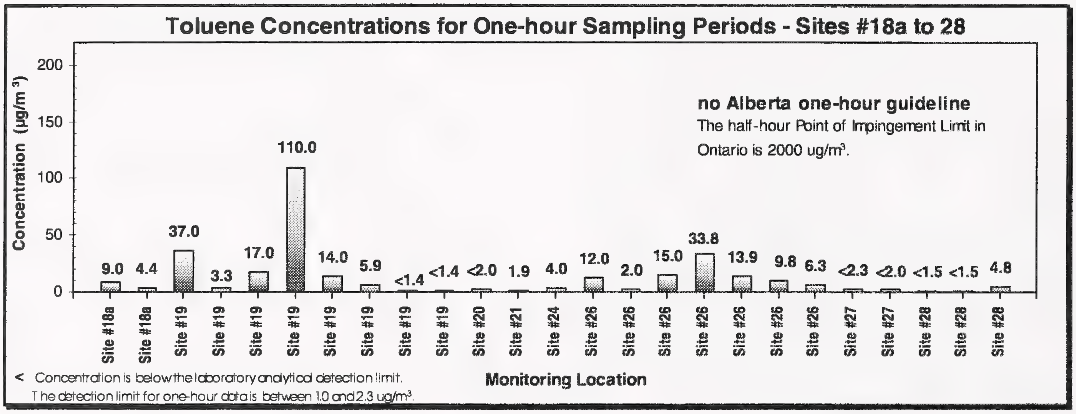


Toluene Concentrations for One-hour Sampling Periods ** - Sites #1 to #18a

no Alberta one-hour guideline
The half-hour Point of Impingement Limit in Ontario is 2000 ug/m³.

< Concentration is below the laboratory analytical detection limit. The detection limit for one-hour data is between 1.0 and 2.3 ug/m³.

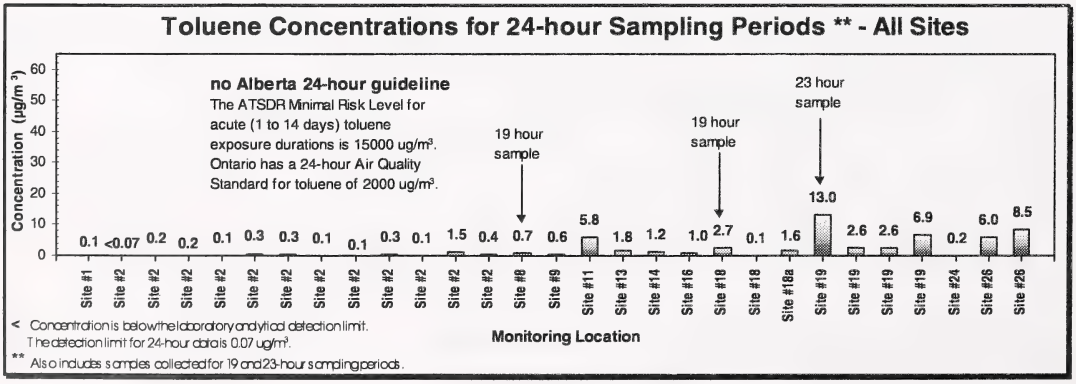
** Also includes samples collected for three and six-hour sampling periods.



Toluene Concentrations for One-hour Sampling Periods - Sites #18a to 28

no Alberta one-hour guideline
The half-hour Point of Impingement Limit in Ontario is 2000 ug/m³.

< Concentration is below the laboratory analytical detection limit. The detection limit for one-hour data is between 1.0 and 2.3 ug/m³.



Toluene Concentrations for 24-hour Sampling Periods ** - All Sites

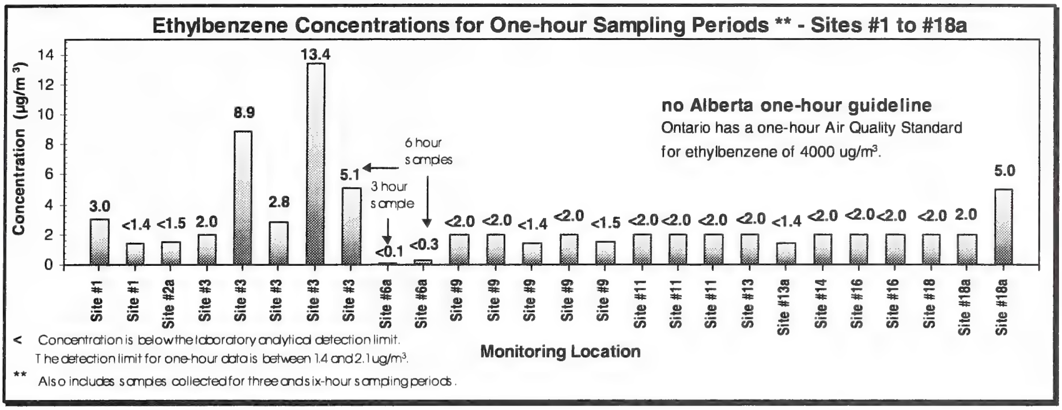
no Alberta 24-hour guideline
The ATSDR Minimal Risk Level for acute (1 to 14 days) toluene exposure durations is 15000 ug/m³. Ontario has a 24-hour Air Quality Standard for toluene of 2000 ug/m³.

< Concentration is below the laboratory analytical detection limit. The detection limit for 24-hour data is 0.07 ug/m³.

** Also includes samples collected for 19 and 23-hour sampling periods.

Figure 2.7 Toluene concentrations in the County of Grande Prairie survey.

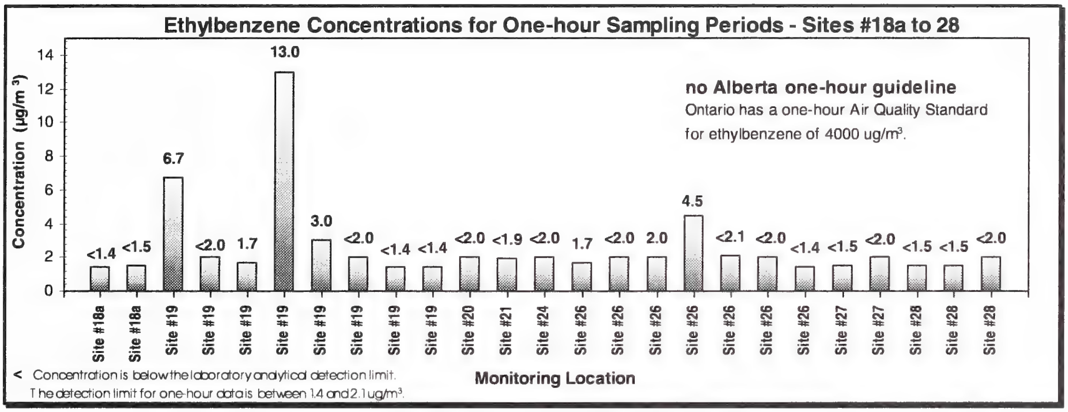
Ethylbenzene Concentrations for One-hour Sampling Periods ** - Sites #1 to #18a



< Concentration is below the laboratory analytical detection limit.
The detection limit for one-hour data is between 1.4 and 2.1 ug/m³.

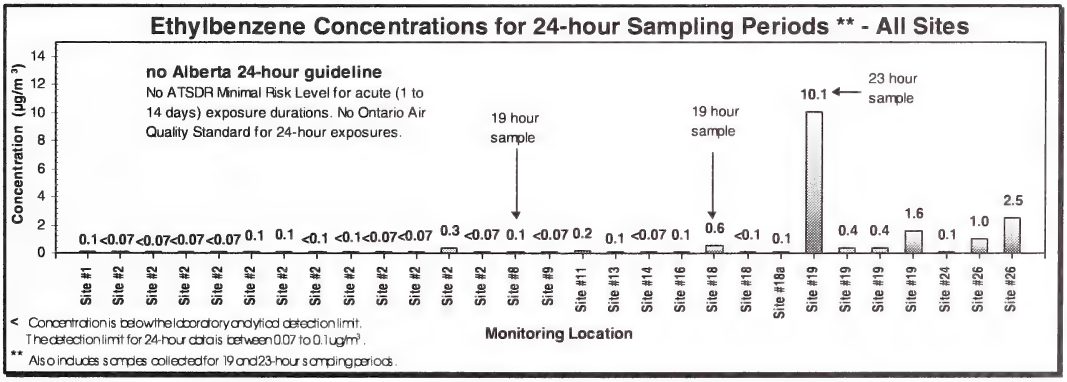
** Also includes samples collected for three and six-hour sampling periods.

Ethylbenzene Concentrations for One-hour Sampling Periods - Sites #18a to 28



< Concentration is below the laboratory analytical detection limit.
The detection limit for one-hour data is between 1.4 and 2.1 ug/m³.

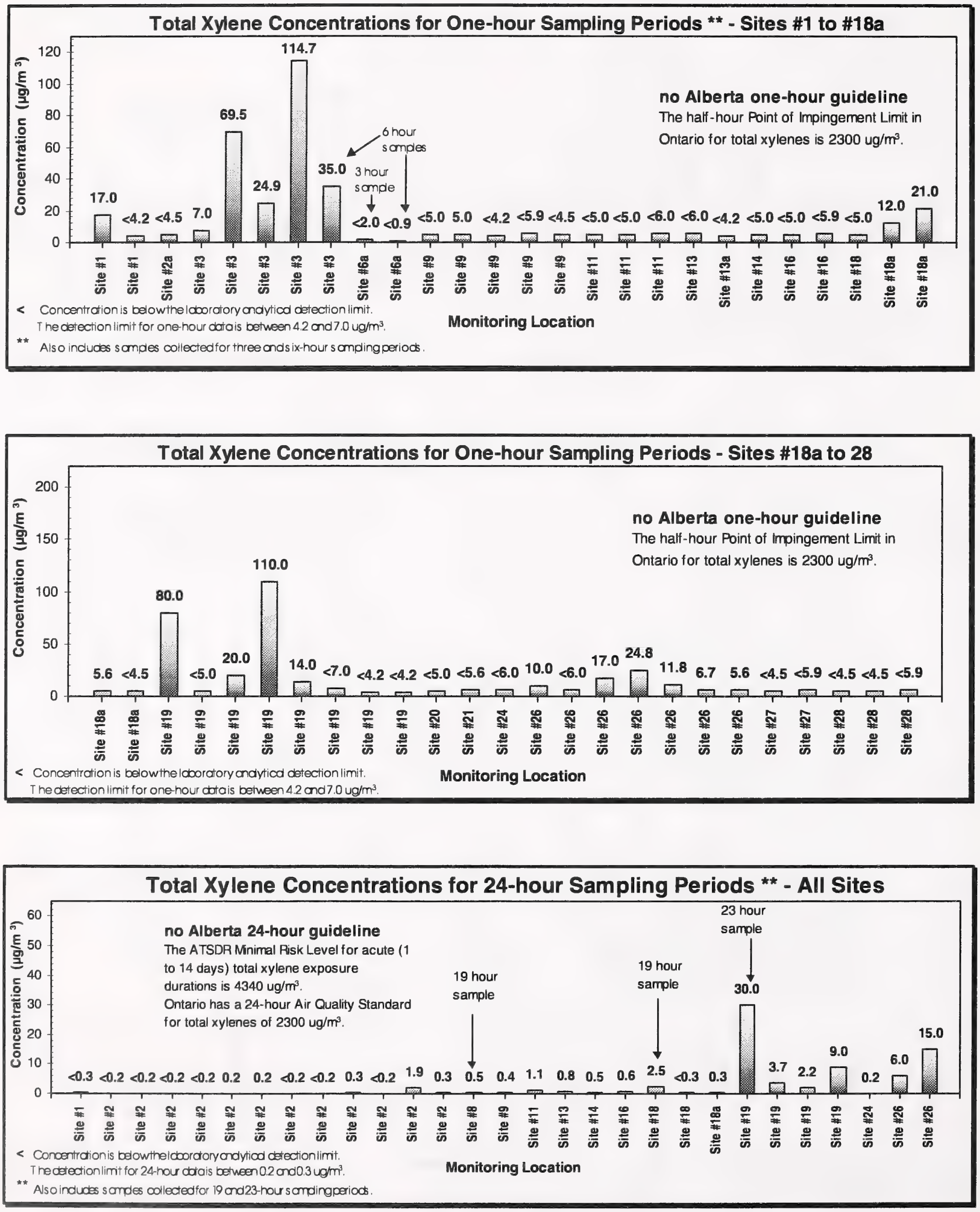
Ethylbenzene Concentrations for 24-hour Sampling Periods ** - All Sites



< Concentration is below the laboratory analytical detection limit.
The detection limit for 24-hour data is between 0.07 to 0.1 ug/m³.

** Also includes samples collected for 19 and 23-hour sampling periods.

Figure 2.8 Ethylbenzene concentrations in the County of Grande Prairie survey.



Total Xylene Concentrations for One-hour Sampling Periods ** - Sites #1 to #18a

no Alberta one-hour guideline
The half-hour Point of Impingement Limit in Ontario for total xylenes is 2300 ug/m³.

< Concentration is below the laboratory analytical detection limit.
The detection limit for one-hour data is between 4.2 and 7.0 ug/m³.

** Also includes samples collected for three and six-hour sampling periods.

Total Xylene Concentrations for One-hour Sampling Periods - Sites #18a to 28

no Alberta one-hour guideline
The half-hour Point of Impingement Limit in Ontario for total xylenes is 2300 ug/m³.

< Concentration is below the laboratory analytical detection limit.
The detection limit for one-hour data is between 4.2 and 7.0 ug/m³.

Total Xylene Concentrations for 24-hour Sampling Periods ** - All Sites

no Alberta 24-hour guideline
The ATSDR Minimal Risk Level for acute (1 to 14 days) total xylene exposure durations is 4340 ug/m³.
Ontario has a 24-hour Air Quality Standard for total xylenes of 2300 ug/m³.

< Concentration is below the laboratory analytical detection limit.
The detection limit for 24-hour data is between 0.2 and 0.3 ug/m³.

** Also includes samples collected for 19 and 23-hour sampling periods.

Figure 2.9 Xylene concentrations in the County of Grande Prairie survey.

Part 3: Passive Monitoring for Sulphur Dioxide and Ozone

Sulphur dioxide (SO_2) and ozone (O_3) were monitored on a monthly basis in the County of Grande Prairie by passive samplers. Passive SO_2 samples were collected at 30 sites over a 14-month period from July 1999 to August 2000. Passive O_3 samples were collected at seven locations over the same 14-month period. Passive data were used primarily to: (1) determine the spatial variation of SO_2 and O_3 in the County of Grande Prairie, and (2) compare SO_2 levels over the 14-month monitoring period with Alberta's annual guideline of 10 parts per billion (ppb).

The passive monitoring network covered a broad geographical area bordered by the western edge of Range 12 to the western edge of Range 2 and from the southern edge of Township 69 to the southern edge of Township 75. The network followed a square grid pattern with a passive SO_2 monitoring site established every two Townships (or 12 miles). Additional SO_2 monitoring sites were set up downwind of major oil and gas facilities. O_3 passive samplers were installed in an "X" pattern so that the spatial variation in O_3 levels over the survey area could be determined. One location, Site #30, located at the Agriculture and Agri-Food Canada Research Farm near Beaverlodge, was used as a regional background station. These passive samplers were co-located with the continuous SO_2 and O_3 analyzers at the Beaverlodge air quality station. The passive monitoring locations are indicated in Figure 3.3.

Monitoring Method

Passive monitoring methods provide a cost-effective solution for monitoring air quality at locations where continuous monitoring is not practical. This method of monitoring uses a passive sampling device (PSD) to monitor air pollutants without the need for electricity, data loggers or pumps. The PSD is a lightweight, portable sampler that works by the physical process of diffusion. No active movement of air through the sampler is necessary. Air pollutants diffuse through a membrane, and collect on a filter, which has been specifically coated to absorb the pollutant of interest. The entire assembly is sent to a laboratory to be analyzed for the amount of pollutant on the filter. From this value, the average ambient concentration of pollutant is calculated using an empirical formula that takes into account the effects of temperature, humidity and wind speed. The disadvantage of using passive systems is that samples are collected over a one-month time period and therefore events that last for short time periods may be "averaged out".

The passive samplers used for monitoring in the County of Grande Prairie survey were the *All Season SO_2 Passive Sampler* and the *All Season O_3 Passive Sampler* developed by Maxxam Analytics. The two samplers use the same basic design consisting of a polycarbonate body, about five centimetres in diameter. The sampling media and a support ring are enclosed in the body. In order to reduce interference by particulate matter and condensation, the sampler was designed to be installed face down in a rain shelter. The diffusion barrier is a Teflon film resembling a piece of lightweight paper that is held in place across the face of the sampler by a plastic ring.

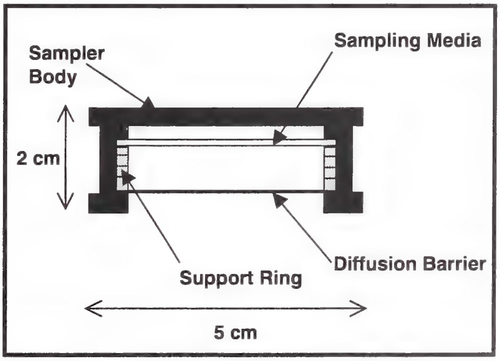
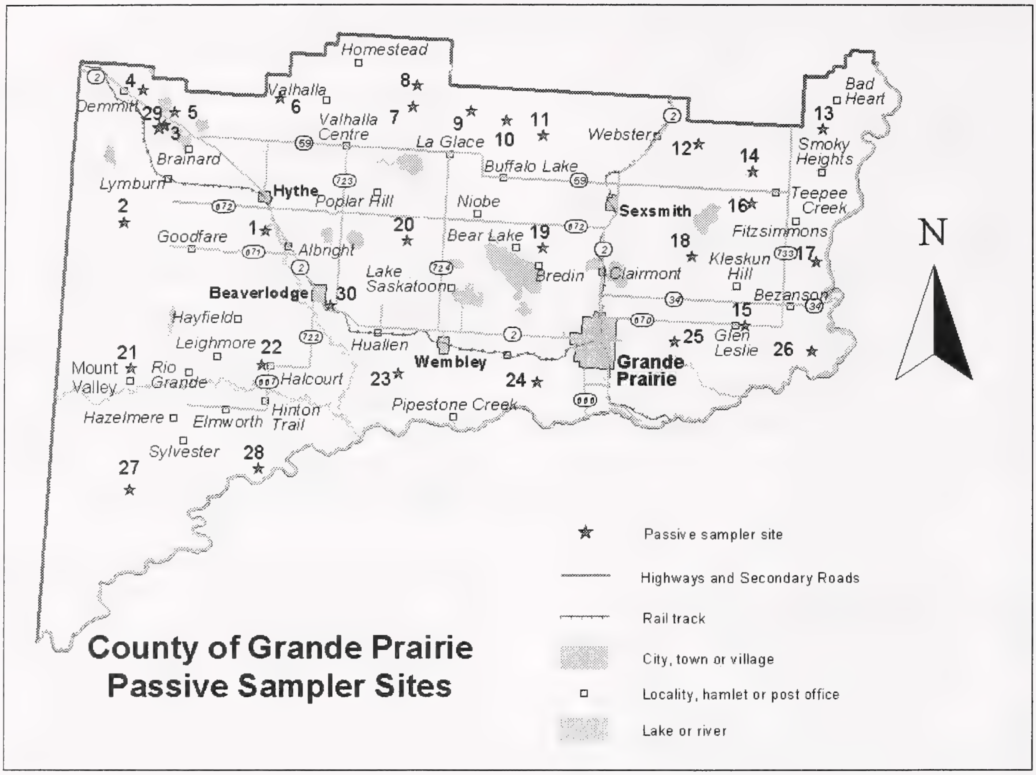


Figure 3.1 Cross-section of passive sampler.



Site #	Location	Longitude	Latitude	Parameters Monitored
1	SW-6-73-10 W6M	119° 33’ 0.2	55° 17’ 0.2	SO_2
2	NE-35-72-13 W6M	119° 52’ 0.4	55° 17’ 0.2	SO_2
3	NE-17-74-12 W6M	119° 47’ 0.8	55° 25’ 0.0	SO_2
4	NE-36-74-13 W6M	119° 51’ 0.1	55° 27’ 0.6	SO_2
5	SW-27-74-12 W6M	119° 46’ 0.5	55° 26’ 0.0	SO_2, O_3
6	NE-36-74-11 W6M	119° 32’ 0.4	55° 27’ 0.6	SO_2
7	NE-36-74-9 W6M	119° 14’ 0.4	55° 27’ 0.6	SO_2
8	SW-17-75-8 W6M	119° 14’ 0.0	55° 29’ 0.3	SO_2
9	NE-36-74-8 W6M	119° 6’ 0.5	55° 27’ 0.6	SO_2
10	SW-33-74-7 W6M	119° 1’ 0.6	55° 27’ 0.0	SO_2
11	NW-19-74-6 W6M	118° 56’ 0.5	55° 26’ 0.0	SO_2
12	NE-19-74-4 W6M	118° 35’ 0.4	55° 26’ 0.0	SO_2, O_3
13	NW-31-74-2 W6M	118° 18’ 0.8	55° 27’ 0.6	SO_2
14	NE-12-74-4 W6M	118° 27’ 0.9	55° 24’ 0.0	SO_2
15	NE-36-71-4 W6M	118° 27’ 0.9	55° 12’ 0.0	SO_2
16	SE-36-73-4 W6M	118° 27’ 0.9	55° 21’ 0.5	SO_2
17	NW-36-72-3 W6M	118° 18’ 0.8	55° 17’ 0.2	SO_2
18	SW-05-73-4 W6M	118° 35’ 0.4	55° 17’ 0.2	SO_2
19	SW-06-73-6 W6M	118° 55’ 0.7	55° 17’ 0.2	SO_2, O_3
20	SW-06-73-8 W6M	119° 14’ 0.0	55° 17’ 0.2	SO_2
21	NW-30-70-12 W6M	119° 50’ 0.0	55° 5’ 0.9	SO_2
22	SW-06-71-10 W6M	119° 32’ 0.4	55° 6’ 0.8	SO_2
23	NW-31-70-8 W6M	119° 14’ 0.0	55° 6’ 0.8	SO_2, O_3
24	SW-06-71-6 W6M	118° 55’ 0.4	55° 6’ 0.8	SO_2
25	NE-25-71-5 W6M	118° 37’ 0.1	55° 10’ 0.5	SO_2
26	SW-30-71-2 W6M	118° 18’ 0.8	55° 10’ 0.3	SO_2, O_3
27	SE-06-69-12 W6M	119° 49’ 0.0	54° 56’ 0.5	SO_2, O_3
28	SW-24-69-11 W6M	119° 32’ 0.0	54° 58’ 0.8	SO_2
29	not available	119° 47’ 0.9	55° 24’ 0.9	SO_2
30	Beaverlodge station	119° 23’ 0.7	55° 11’ 0.8	SO_2, O_3

Figure 3.2 Location of passive monitoring sites in the County of Grande Prairie survey.

Meteorological Data

Meteorological factors, such as temperature, humidity and wind speed, are important when calculating ambient concentrations from passive samplers. These factors will affect the sampling rate of SO_2 and O_3 on to the collection media of the passive sampler. Weather information, such as wind direction, is also important in assessing the general transport of pollutants in the monitoring area. Meteorological information used to calculate SO_2 and O_3 concentrations from passive samplers are based on data from the Beaverlodge air quality station located at the Agriculture and Agri-Food Research Farm near Beaverlodge. These data are presented in Table 3.1 and Figure 3.4.

Winds were pre-dominantly from the southwest to west directions from July 1999 to August 2000. Winds from these directions were measured about 36 per cent of the time over this 14-month time period. The next most frequent wind directions were from the east (19 per cent of the time) and northwest (17 per cent of the time) directions. Southwest to west winds were most common in almost all months except for January and February of 2000 when winds with an easterly component were more frequent. Monthly average wind speeds ranged from 4.2 kilometres per hour (km/h) in February 2000 to 14.9 km/h in October 1999. Calm winds were recorded about 2 per cent of the time over the 14-month monitoring period.

Monthly average ambient temperatures at the Beaverlodge air quality station ranged from -12.3 °C in January 2000 to 16.1 °C in August 1999. Average monthly temperatures were above 10 °C from July to August 1999 and June to August 2000. Average temperatures were below 0 °C from November 1999 to March 2000.

Monthly average relative humidity values at the Beaverlodge station were close to 60 per cent from July to October 1999 and from April to June 2000. The lowest monthly average relative humidity of 56 per cent was measured in April. The highest monthly average relative humidity was measured in November 1999 with a value of 79 per cent. No relative humidity data is available for July 2000 because of an instrument malfunction.

Table 3.1 Weather condition at the Beaverlodge air quality station during the passive monitoring period.

Month	Predominant Wind Directions	Average Wind Speed (km/h)	Average Temperature (°C)	Average Relative Humidity (%)
July, 1999	southwest to west	12.9	14.5	59.0
August, 1999	west-southwest to west	10.4	16.1	59.2
September, 1999	west-southwest to west	9.7	10.2	61.9
October, 1999	southwest to west	14.9	4.9	60.7
November, 1999	southwest to west	8.0	-2.5	78.6
December, 1999	southwest to west	10.3	-3.2	69.1
January, 2000	east, west-southwest and northwest	6.3	-12.3	71.0
February, 2000	north-northeast to east and northwest	4.2	-7.1	70.4
March, 2000	east and west-southwest	11.3	-3.0	68.9
April, 2000	west-southwest	13.0	3.2	56.2
May, 2000	west-southwest to west	13.3	7.3	60.6
June, 2000	west-southwest to west	12.2	13.3	60.3
July, 2000	west-southwest to west	10.8	15.7	no data
August, 2000	west-southwest to northwest	10.8	12.9	76.2

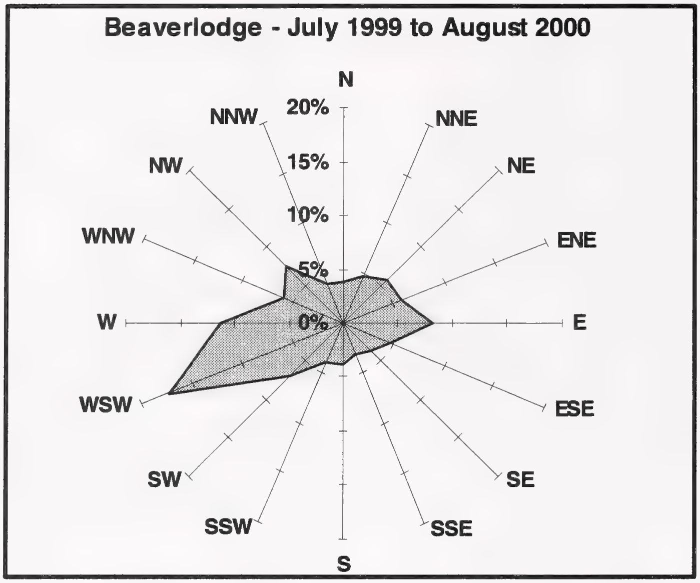


Figure 3.3 **Wind direction frequency distribution at the Beaverlodge air quality station from July 1999 to August 2000.**

Results from Passive SO_2 Data

Alberta Environment monitored for SO_2 using passive samplers at 30 sites in the County of Grande Prairie from July 1999 to August 2000. The resulting data set consists of monthly SO_2 concentrations at each site for this 14-month period (Figures 3.5 and 3.6). The monthly SO_2 monitoring results and isopleth maps are presented in Appendix C.

SO_2 levels were consistently low at all passive monitoring locations in the County of Grande Prairie survey. The maximum monthly concentration was 3.4 ppb and was measured in January at Site #8. The next highest monthly SO_2 concentration was 3.1 ppb recorded in January and February at Site #13. Monthly SO_2 concentrations were lower than 3 ppb at the remaining passive monitoring sites. Alberta does not have a monthly guideline for SO_2. However, monthly SO_2 concentrations were below Alberta's annual guideline of 10 ppb at all locations.

SO_2 concentrations were generally higher at passive monitoring sites located near sour gas facilities. Based on average concentrations over the 14-month monitoring period, the highest SO_2 values were measured at Sites #3, #8, #12, #13 and #29. Sites #3 and #29 were located downwind of the AEC West Hythe Brainard gas plant and Site #8 was located near the AEC West Sexsmith gas plant. SO_2 levels at Sites #12 and #13 may have been influenced by smaller sour gas facilities located close to the monitoring sites. The 14-month average SO_2 concentration measured at these five sites ranged from 1.2 to 1.5 ppb, respectively. Concentrations were lower than 1 ppb at the remaining 25 sites for the 14-month time period. Average SO_2 concentrations at all sites were well below the annual guideline of 11 ppb.

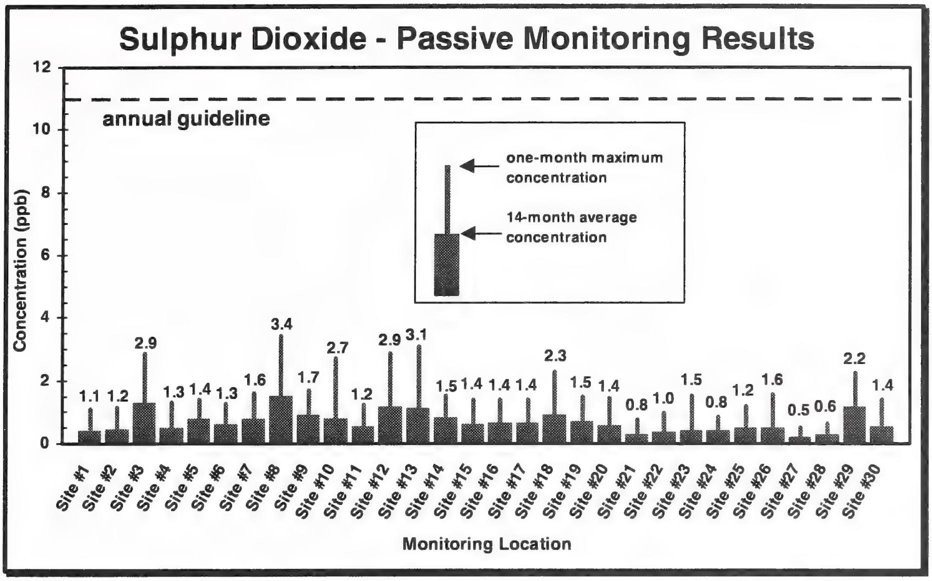


Figure 3.4 Average and maximum monthly sulphur dioxide concentrations (ppb) from passive monitoring sites in the County of Grande Prairie.

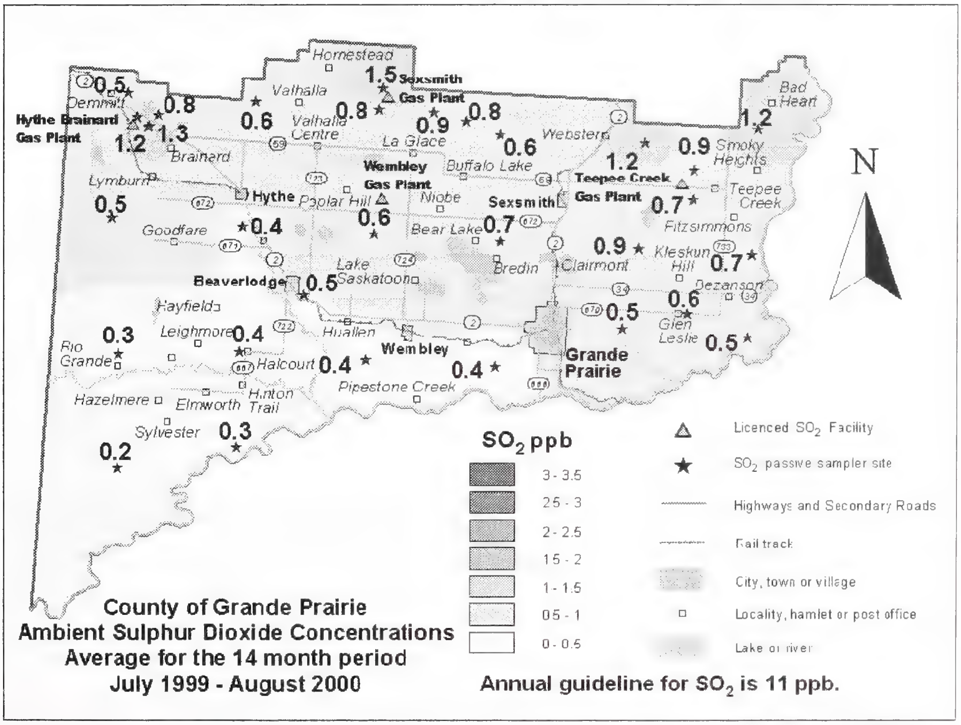


Figure 3.5 Average sulphur dioxide concentrations (ppb) from July 1999 to August 2000 at passive monitoring sites in the County of Grande Prairie.

SO_2 concentrations did show a definite seasonal variation based on passive sampling results. The highest concentrations were measured in the winter months of December, January and February. The average concentrations including all stations for these months were 1.2, 1.5 and 1.2 ppb, respectively. The lowest levels were measured in the spring, summer and fall when average monthly concentrations including all 30 sites ranged from 0.4 to 0.6 ppb from April to October (1999 and 2000). Lower ambient SO_2 values in the spring, summer and fall were likely due to better dispersion conditions with stronger wind speeds and a lower frequency of temperature inversions.

Ambient SO_2 concentrations did not necessarily correlate with SO_2 emissions in the region. Total SO_2 emissions (including incinerators and flares) from the major licensed gas plants in the area were highest in July (423 tonnes) and August (380 tonnes) of 1999. The lowest emissions were in July 2000 when 299 tonnes of SO_2 were emitted from licensed sources. SO_2 emissions from licensed sources were relatively consistent throughout the remainder of the monitoring period with emissions ranging from 312 to 355 tonnes per month. The monthly SO_2 emissions from licensed facilities in the County of Grande Prairie are indicated in Table 3.2.

SO_2 concentrations over the 14-month period were lower in the County of Grande Prairie than at many other locations in the province (see Figure 3.7 and Appendix C). The overall average SO_2 concentration at all 30 stations in the County of Grande Prairie passive network was 0.7 ppb. This value is lower than average SO_2 concentrations for the same 14-month time period at stations located in Calgary, Edmonton, Fort Saskatchewan, Sherwood Park and near industries in the Fort McMurray area. SO_2 levels at stations in these areas ranged from 1.0 to 2.9 ppb for the same time period. The average SO_2 concentration in the County of Grande Prairie passive network was similar to those measured at the Red Deer (0.8 ppb) and Fort McMurray Athabasca Valley (0.8 ppb) monitoring stations. Background SO_2 levels are about 0.1 ppb (based on data from the Hightower Ridge station located 65 km north-northwest of Hinton).

SO_2 levels measured by the passive sampler located at the Beaverlodge Agriculture and Agri-Food Canada Research Farm (Site #30) were consistent with those recorded by the co-located continuous analyzer. Monthly SO_2 concentrations from the passive sampler were within 0.1 ppb of the monthly average SO_2 concentrations from the continuous sampler in all months except for January. In January, the SO_2 values measured using these two methods differed by 0.4 ppb. The average SO_2 concentration at the Beaverlodge station from both methods over the 14-month monitoring period was 0.5 ppb.

Table 3.2 Actual sulphur dioxide emissions from major gas plants in the County of Grande Prairie survey (tonnes).*

Gas Plant	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Total
AEC West Hythe Brainard (flaring)	2	0	0	0	0	0	0	2	0	0	0	0	0	1	**4**
AEC West Hythe Brainard (incinerator)	60	52	46	44	41	43	47	50	44	56	47	41	43	46	**660**
AEC West Sexsmith (flaring)	33	0	0	0	0	5	2	0	0	0	18	0	0	12	**68**
AEC West Sexsmith (incinerator)	229	221	206	216	192	211	222	204	200	197	200	227	200	215	**2939**
Talisman Energy Teepee Creek (flaring)	0	1	0	0	0	0	0	0	0	1	0	0	0	0	**3**
Talisman Energy Teepee Creek (incinerator)	85	91	79	72	64	64	68	79	87	77	76	32	41	34	**950**
Crestar Energy Wembley (flaring)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Crestar Energy Wembley (incinerator)	15	15	14	14	14	15	15	14	15	14	15	14	15	15	**203**
Total (incinerator)	389	379	345	346	312	333	352	347	345	345	337	314	298	310	**4751**
Total (flaring)	34	1	0	0	0	5	2	2	0	1	18	0	0	12	**75**
Total (incinerator and flaring)	**423**	**380**	**345**	**346**	**312**	**338**	**354**	**349**	**345**	**346**	**355**	**314**	**299**	**322**	**4826**

*Monthly sulphur dioxide emissions are obtained from monthly reports provided by industry.

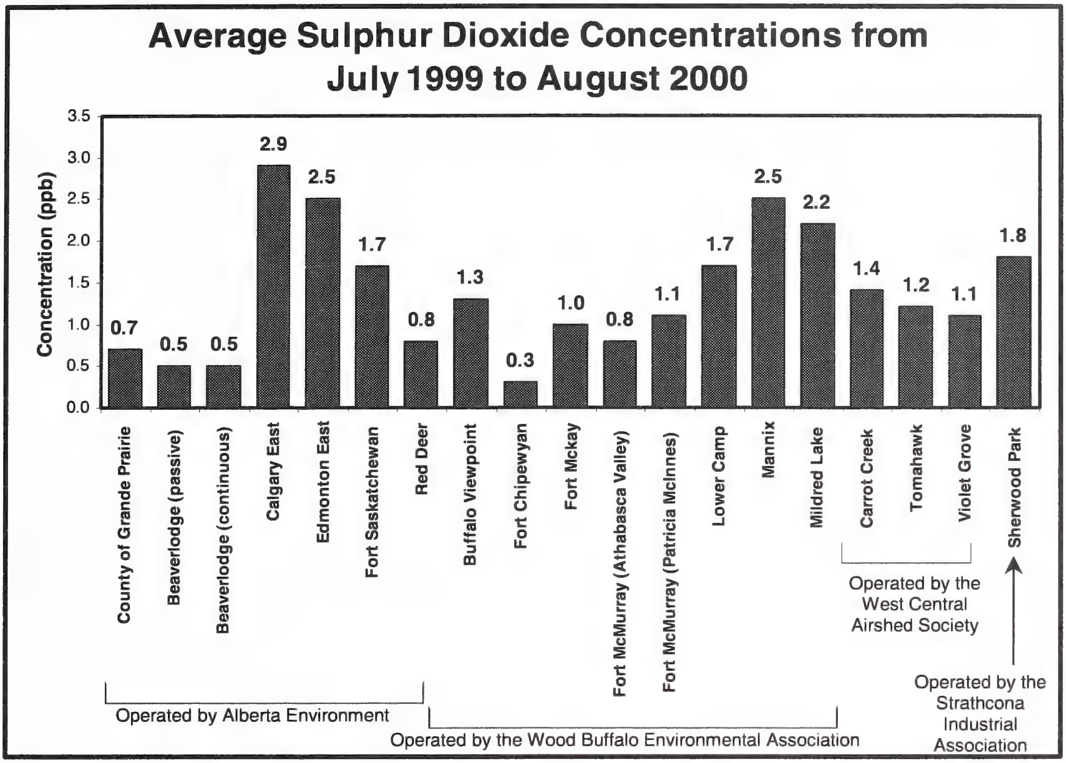


Figure 3.6 Average sulphur dioxide concentrations for other Alberta monitoring stations from July 1999 to August 2000.

Results from Passive O_3 Data

O_3 was measured using passive samplers at seven sites in the County of Grande Prairie (see Figure 3.3 for locations). The results of the 14-month sampling program are presented in Table 3.3 and Figure 3.8.

High levels of O_3 at rural locations in Alberta occur because of natural O_3 generating processes. In the fall, winter and early spring, most of the O_3 at ground level is the result of transport from the "ozone-rich" upper atmosphere through natural meteorological processes. Natural O_3 is also produced through chemical reactions involving organic compounds (primarily from vegetation) and oxides of nitrogen. These chemical reactions need sunlight and heat to occur and therefore are more prevalent in the late spring and summer seasons. Ground-level O_3 concentrations are usually lower in large urban centres, such as Edmonton and Calgary, because of the destruction of natural O_3 by nitric oxide emitted from automobiles and other sources.[9]

O_3 levels from the County of Grande Prairie passive sampling network showed the typical seasonal trend that is observed at other rural locations in Alberta. The highest monthly concentrations were measured from February to May 2000.

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[9] Angle, R.P and H.S. Sandhu. 1989. *Urban and rural ozone concentrations in Alberta, Canada.* Atmospheric Environment 23: 215-221.

Table 3.3 Monthly average ozone concentrations from passive samplers in the County of Grande Prairie survey (ppb).

Site	Jul 1999	Aug 1999	Sep 1999	Oct 1999	Nov 1999	Dec 1999	Jan 2000	Feb 2000	Mar 2000	Apr 2000	May 2000	Jun 2000	Jul 2000	Aug 2000	14-month Average
#5	16	17	13	21	15	25	24	28	32	28	26	20	13	13	**21**
#12	n/a	15	22	28	27	33	32	41	40	32	30	25	23	19	**28**
#19	17	n/a	15	21	17	42	27	33	38	30	28	23	20	14	**25**
#23	16	19	14	23	13	25	22	29	35	29	30	22	18	14	**22**
#26	16	17	n/a	21	15	23	19	24	30	30	27	20	17	14	**21**
#27	18	16	13	24	14	28	21	22	28	27	24	20	16	13	**20**
#30	29	27	20	28	n/a	30	26	32	35	34	33	29	24	21	**28**
Average	**19**	**18**	**16**	**24**	**17**	**29**	**24**	**30**	**34**	**30**	**28**	**23**	**19**	**16**	**24**

n/a Indicates sample was missing, damaged or destroyed.

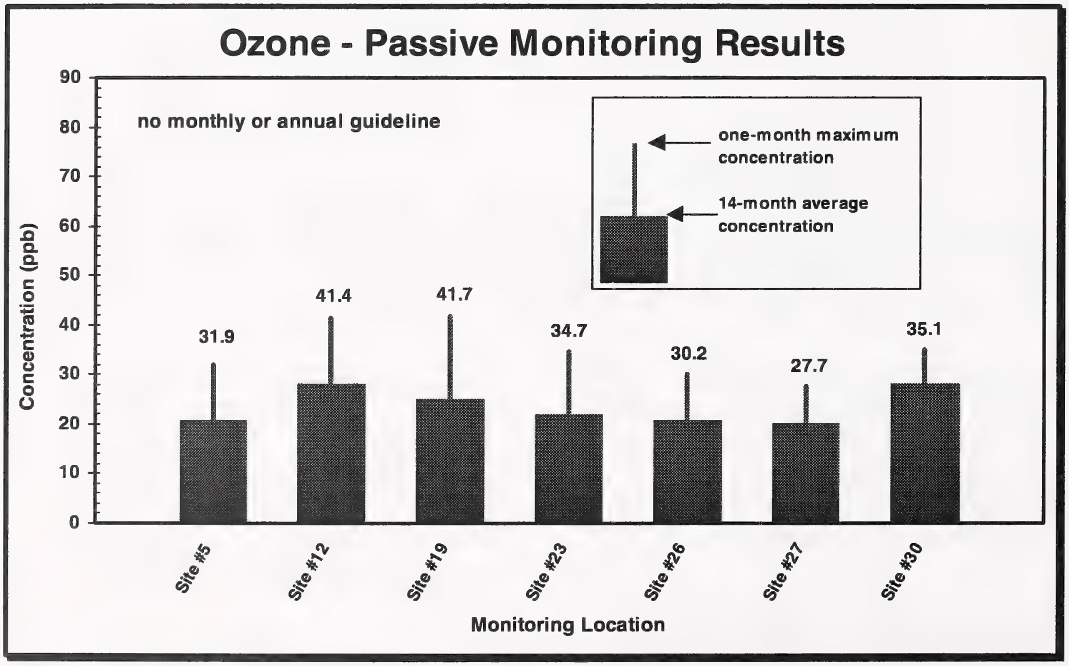

Figure 3.7 Average and maximum monthly ozone concentrations (ppb) from passive monitoring sites in the County of Grande Prairie.

The average monthly O_3 concentrations from all seven stations in these months ranged from 28 to 34 ppb. However, relatively high monthly O_3 levels were also measured in October (24 ppb) and December (29 ppb) at all stations. The average wind speed in October and December was also higher than in the adjacent months. Higher wind speeds in these months could result in more natural O_3 being transported from the upper atmosphere. The lowest monthly O_3 levels were measured from July to September 1999, November 1999, and in July and August 2000. O_3 levels were lower than 20 ppb, as an average from all stations, in these months.

O_3 levels measured at the Beaverlodge air quality station (Site #30) using passive samplers were consistent with those recorded at the same location using a continuous analyzer. Monthly O_3 concentrations from the passive samplers were within 7 ppb (about 20%) of the monthly average from the continuous analyzer (see Table C.3 in Appendix C). The 14-month average O_3 concentration was the same using both passive and continuous monitoring techniques (28 ppb) at the Beaverlodge station.

O_3 levels at the Beaverlodge passive station were often higher than those measured at some other passive monitoring sites in the County of Grande Prairie. These differences were most pronounced in July, August and September of 1999 and July and August of 2000. For example, monthly O_3 concentrations in July and August of 1999 at the Beaverlodge station were 29 and 27 ppb, respectively. Monthly O_3 concentrations in these two months at other passive monitoring stations in the survey area ranged from 16 to 19 ppb. Monthly O_3 levels at rural monitoring stations operated by the West Central Airshed Society (WCAS) in July and August of 1999 ranged from 23 to 30 ppb (see Table C.3 in Appendix C). These values are consistent with those measured at the Beaverlodge air quality station. A number of factors may have contributed to lower than expected O_3 concentrations at some stations in the County of Grande Prairie passive network. These include:

(1) differences in vegetation surrounding the passive sites leading to different emission rates of organic compounds and therefore different ambient O_3 levels, or
(2) O_3 destruction from nitric oxide emitted by automobiles from roads near passive monitoring sites.

The reason for lower O_3 levels during the summer and early fall months at some passive monitoring sites could not be conclusively determined.

The average O_3 concentration for the 14-month monitoring period at all seven passive stations in the County of Grande Prairie was 24 ppb. This value is lower than average ozone levels measured at the five rural stations operated by the WCAS located in the Drayton Valley, Edson and Hinton areas (29 to 44 ppb for the same time period). However, O_3 levels at rural stations located near Fort McKay and Fort Chipewyan (operated by the Wood Buffalo Environmental Association) in northeastern Alberta over this 14-month time period were 19 and 26 ppb, respectively. These levels are similar to the overall average measured from the County of Grande Prairie network. The 14-month average O_3 concentration at stations located in Edmonton, Calgary, Red Deer, Fort Saskatchewan and Fort McMurray ranged from 15 to 23 ppb. As mentioned earlier, lower average O_3 levels are measured in urban areas because of nitric oxide emitted by automobiles that destroys naturally produced O_3. Concentrations of O_3 at other locations in Alberta for the 14-month monitoring period are presented in Figure 3.9 and Table C.3 in Appendix C.

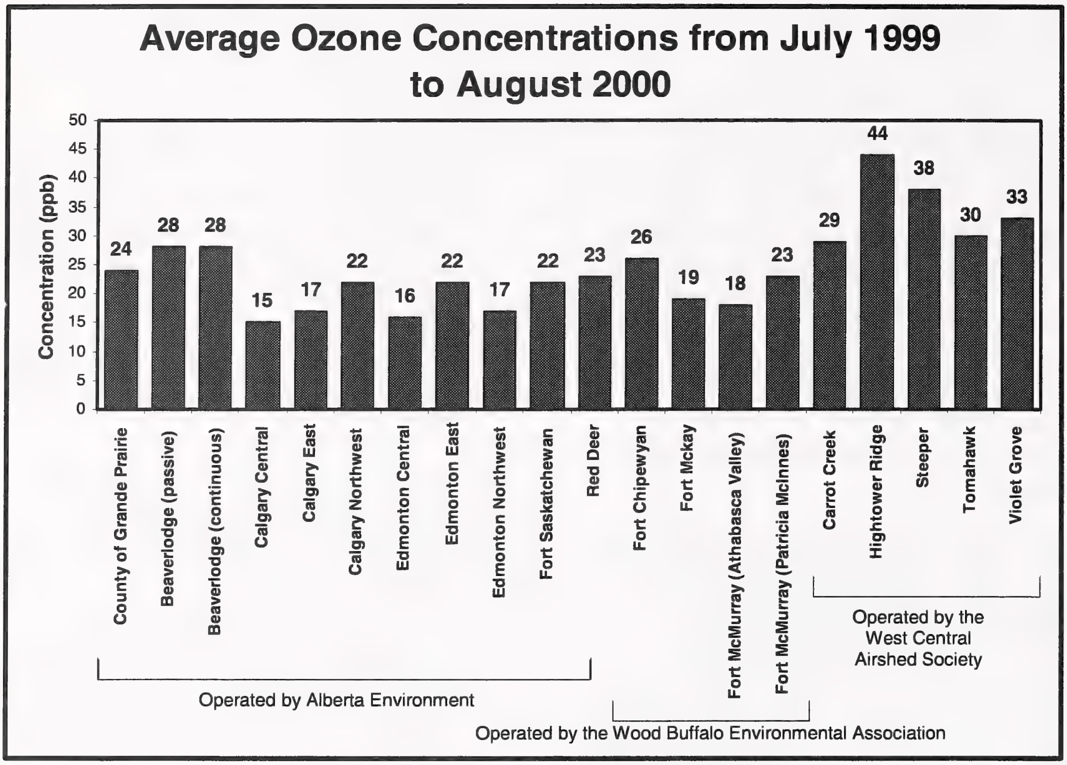

Figure 3.8 Average ozone concentrations for other Alberta monitoring stations from July 1999 to August 2000.

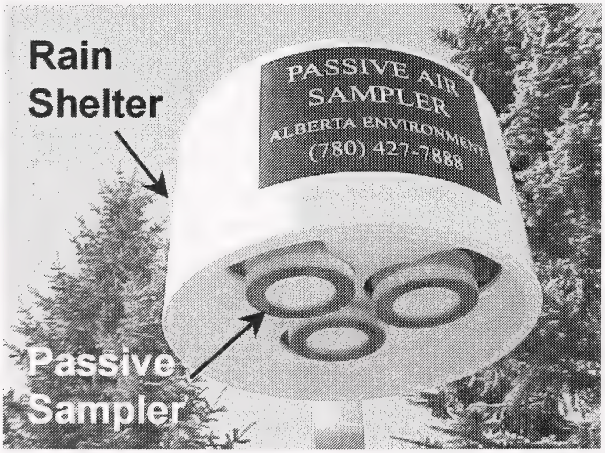

Figure 3.9 Passive samplers mounted inside rain shelter.

Table A.1 Median one-hour air quality parameter concentrations at each mobile monitoring site in the County of Grande Prairie (December 1998 to October 1999).

Monitoring	CO	O_3	THC	CH_4	RHC	SO_2	NO	NO_2	NO_x	NH_3	TRS	H_2S	TSP	PM_{10}	$PM_{2.5}$	PAH
Location	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	μg/m³			ng/m³
Site # 1	0.2	0.025	2.3	1.9	0.4	0.001	0.003	0.003	0.005	0.002	0.000	0.000	19	10	1	2
Site # 2	0.2	0.033	1.9	1.6	0.2	0.000	0.000	0.001	0.003	0.001	0.000	0.000	9	5	2	2
Site # 3	0.2	0.026	2.5	1.9	0.3	0.001	0.005	0.003	0.009	0.003	0.001	0.000	14	8	1	2
Site # 4	0.1	0.038	2.0	1.7	0.2	0.000	0.000	0.001	0.001	0.001	0.000	0.000	12	9	2	1
Site # 5	0.1	0.036	2.0	1.6	0.2	0.000	0.000	0.001	0.001	0.001	0.000	0.000	13	9	2	1
Site # 6	0.2	0.035	2.0	1.7	0.2	0.002	0.002	0.002	0.004	0.001	0.000	0.000	11	6	1	2
Site # 7	0.3	0.045	1.9	1.6	0.2	0.001	0.001	0.001	0.002	0.001	0.001	0.001	18	10	2	1
Site # 8	0.2	0.037	2.0	1.7	0.3	0.000	0.002	0.002	0.003	0.001	0.001	0.001	14	9	2	1
Site # 9	0.1	0.037	2.5	1.7	0.5	0.001	0.003	0.003	0.005	0.001	0.000	0.000	11	8	2	3
Site # 10	0.1	0.036	1.9	1.7	0.2	0.001	0.001	0.002	0.003	0.002	0.000	0.001	51	29	4	2
Site # 11	0.1	0.036	2.2	1.7	0.3	0.001	0.001	0.001	0.001	0.001	0.000	0.000	9	6	3	2
Site # 12	0.2	0.039	2.0	1.7	0.2	0.001	0.001	0.001	0.002	0.001	0.000	0.000	6	4	1	1
Site # 13	0.3	0.029	2.1	1.7	0.2	0.001	0.003	0.003	0.005	0.002	0.001	0.000	9	6	1	2
Site # 14	0.3	0.035	2.0	1.6	0.2	0.002	0.001	0.001	0.002	0.001	0.001	0.001	20	11	1	2
Site # 15	0.3	0.040	2.1	1.7	0.3	0.002	0.000	0.001	0.001	0.001	0.001	0.000	22	13	2	2
Site # 16	0.1	0.033	2.4	1.8	0.5	0.000	0.003	0.003	0.006	0.001	0.000	0.000	51	37	4	2
Site # 17	0.2	0.039	1.9	1.7	0.2	0.001	0.001	0.001	0.002	0.001	0.000	0.000	18	12	2	2
Site # 18	0.2	0.036	2.1	1.7	0.3	0.001	0.002	0.003	0.004	0.001	0.001	0.001	14	9	1	2
Site # 19	0.2	0.035	2.0	1.7	0.4	0.001	0.003	0.003	0.004	0.001	0.001	0.001	54	31	3	3
Site # 20	0.1	0.039	1.9	1.6	0.2	0.003	0.001	0.001	0.002	0.001	0.000	0.000	42	25	3	2
Site # 21	0.2	0.032	2.0	1.7	0.2	0.006	0.002	0.002	0.005	0.001	0.002	0.002	12	6	1	2
Site # 22	0.1	0.037	2.1	1.7	0.2	0.001	0.003	0.003	0.004	0.001	0.001	0.001	4	2	1	2
Site # 23	0.2	0.031	2.0	1.6	0.3	0.001	0.002	0.002	0.003	0.002	0.000	0.000	10	5	1	2
Site # 24	0.1	0.031	2.1	1.7	0.2	0.001	0.002	0.002	0.005	0.002	0.001	0.001	11	7	1	2
Site # 25	0.1	0.046	1.9	1.7	0.2	0.001	0.001	0.001	0.002	0.001	0.001	0.000	14	8	1	1
Site # 26	0.2	0.035	6.1	2.1	3.7	0.003	0.002	0.001	0.002	0.001	0.000	0.000	29	15	2	2
Site # 27	0.2	0.034	2.0	1.7	0.3	0.001	0.002	0.002	0.004	0.001	0.000	0.001	no data			19
Site # 28	0.2	0.033	1.8	1.6	0.2	0.002	0.000	0.001	0.001	0.001	0.000	0.001	no data			0
Overall median	0.2	0.035	2.0	1.7	0.2	0.001	0.001	0.002	0.003	0.001	0.000	0.000	14	9	2	2

no data - Indicates that analyzer was not operational for the indicated time period.

Table A.2 Maximum one-hour air quality parameter concentrations at each mobile monitoring site in the County of Grande Prairie (December 1998 to October 1999).

Monitoring Location	CO	O_3	THC	CH_4	RHC	SO_2	NO	NO_2	NO_x	NH_3	TRS	H_2S	TSP	PM_{10}	$PM_{2.5}$	PAH
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	µg/m³			ng/m³
Site # 1	0.4	0.031	4.7	3.9	0.9	0.004	0.071	0.044	0.083	0.022	0.002	0.002	200	137	16	6
Site # 2	0.5	0.052	2.4	1.9	0.7	0.003	0.008	0.008	0.017	0.004	0.001	0.002	71	39	6	5
Site # 3	0.6	0.052	>6.8	>3.2	>3.9	0.003	**0.087**	0.026	0.091	0.014	0.002	0.002	65	47	8	3
Site # 4	0.4	0.052	2.7	2.1	0.7	0.002	0.003	0.006	0.007	0.003	0.001	0.002	67	41	4	3
Site # 5	0.5	0.053	2.3	1.7	0.6	0.004	0.005	0.010	0.012	0.002	0.001	0.002	137	75	7	3
Site # 6	0.7	0.053	2.2	1.8	0.4	0.008	0.007	0.009	0.011	0.006	0.002	0.002	1099	669	63	9
Site # 7	0.4	0.052	2.2	1.8	0.3	0.003	0.006	0.001	0.007	0.002	0.001	0.001	63	24	2	2
Site # 8	0.6	0.050	2.9	2.2	0.6	0.005	0.025	0.015	0.040	0.008	0.002	0.002	39	23	3	4
Site # 9	0.7	**0.064**	3.6	2.4	1.8	0.003	0.049	**0.061**	0.093	0.012	0.002	0.002	50	34	4	11
Site # 10	0.6	0.061	3.9	3.0	0.8	0.004	0.027	0.014	0.040	0.008	0.002	0.002	**2305**	**1287**	**101**	12
Site # 11	0.3	0.056	3.9	2.8	1.3	0.002	0.009	0.009	0.016	0.004	0.002	0.002	60	35	5	3
Site # 12	0.3	0.054	3.2	2.7	0.5	0.003	0.016	0.009	0.025	0.003	0.001	0.002	28	15	2	5
Site # 13	0.6	0.053	7.2	4.0	3.3	0.017	0.056	0.050	**0.103**	**0.030**	0.002	0.002	85	56	7	10
Site # 14	0.3	0.053	2.1	1.7	0.7	0.020	0.003	0.006	0.007	0.006	0.003	0.003	32	18	3	14
Site # 15	0.4	0.040	2.2	1.7	0.5	0.002	0.000	0.002	0.001	0.001	0.001	0.000	34	20	2	2
Site # 16	0.5	0.054	3.4	2.5	1.1	0.006	0.007	0.013	0.018	0.003	0.001	0.001	110	69	7	15
Site # 17	0.3	0.055	2.2	1.9	0.4	0.003	0.003	0.005	0.006	0.006	0.002	0.001	158	94	9	12
Site # 18	0.4	0.055	6.8	4.0	2.4	0.016	0.008	0.019	0.026	0.005	**0.010**	**0.009**	74	41	4	5
Site # 19	0.3	0.052	3.3	2.5	0.9	0.003	0.025	0.018	0.038	0.012	0.004	0.004	891	655	60	13
Site # 20	0.3	0.049	2.4	2.0	0.4	**0.043**	0.006	0.008	0.014	0.005	0.002	0.002	118	71	8	18
Site # 21	0.6	0.055	2.7	2.2	0.4	0.021	0.015	0.009	0.024	0.006	0.005	0.006	50	34	6	20
Site # 22	0.3	0.055	2.3	1.9	0.4	0.004	0.003	0.007	0.008	0.002	0.002	0.002	47	32	4	3
Site # 23	0.7	0.042	2.6	2.2	0.4	0.004	0.014	0.008	0.018	0.008	0.001	0.002	62	37	4	4
Site # 24	0.4	0.050	2.4	2.1	0.3	0.005	0.009	0.008	0.012	0.010	0.002	0.002	38	25	4	18
Site # 25	0.3	0.057	2.0	1.7	0.2	0.004	0.002	0.002	0.003	0.002	0.001	0.001	50	31	4	19
Site # 26	**1.0**	0.056	**> 32.4**	**>6.4**	**>29.4**	0.008	0.021	0.010	0.030	0.004	0.001	0.001	62	33	3	12
Site # 27	0.4	0.036	2.1	1.7	0.4	0.002	0.003	0.002	0.005	0.001	0.000	0.001	no data			**35**
Site # 28	0.3	0.035	1.8	1.6	0.3	0.003	0.001	0.001	0.001	0.001	0.000	0.001	no data			0
One-Hour Maximum	**1.0**	**0.064**	**> 32.4**	**>6.4**	**>29.4**	**0.043**	**0.087**	**0.061**	**0.103**	**0.030**	**0.010**	**0.009**	**2305**	**1287**	**101**	**35**
One-Hour Guideline	**13.0**	**0.082**	**n/a**	**n/a**	**n/a**	**0.172**	**n/a**	**0.212**	**n/a**	**2.0**	**n/a**	**0.010**	**n/a**	**n/a**	**n/a**	**n/a**

> - Indicates the pollutant exceeded the range of the instrument for a portion of the monitoring period.

Bold text - Indicates the maximum concentration measured during the survey.

no data - Indicates that analyzer was not operational for the indicated time period.

n/a - Indicates that there is no one-hour guideline.

Table A.3 Typical median one-hour air quality parameter concentrations in Alberta*.

Air Quality Station	Station or Survey Type	Monitoring Period	CO	O_3	THC	CH_4	RHC	SO_2	NO_2	NH_3	TRS	H_2S	TSP	PM_{10}	$PM_{2.5}$	PAHs
County of Grande Prairie[1]	mobile survey	Dec. 1998 to Oct. 1999	0.2	0.036	2.0	1.7	0.2	0.001	0.002	0.001	0.000	0.000	14	9	2	2
Caroline/Sundre area[1]	mobile survey	Apr. 1997 to Apr. 1998	0.3	0.042	2.1	1.8	0.2	0.002	0.009	n/a	0.000	0.000	4	3	1	n/a
City of Lethbridge[1]	mobile survey	Sep. 1998 to Jul. 1999	0.2	0.046	1.9	1.6	0.2	0.000	0.003	0.005	0.000	0.001	17	11	2	3
City of Medicine Hat[1]	mobile survey	May 1998 to Jan. 1999	0.4	0.031	2.1	1.8	0.2	0.001	0.009	0.003	0.000	0.000	16	11	2	5
Lethbridge area (Picture Butte, Sterling)[1]	mobile survey	Sep. 1998 to Jul. 1999	0.2	0.044	2.1	1.8	0.2	0.001	0.002	0.075	0.002	0.001	42	24	3	2
Beaverlodge[2]	rural	Jan. to Dec. 1999	n/a	0.031	n/a	n/a	n/a	0.000	0.003	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Calgary Central[2]	urban	Jan. to Dec. 1999	0.6	0.013	2.1	n/a	n/a	n/a	0.026	n/a	n/a	n/a	47	19	8	n/a
Calgary East[2]	urban	Jan. to Dec. 1999	0.5	0.014	2.2	n/a	n/a	0.003	0.023	n/a	n/a	0.001	86	n/a	n/a	n/a
Calgary Northwest[2]	urban	Jan. to Dec. 1999	0.4	0.021	2.0	n/a	n/a	n/a	0.013	n/a	n/a	n/a	33	n/a	n/a	n/a
Edmonton Central[2]	urban	Jan. to Dec. 1999	0.6	0.014	1.9	n/a	n/a	n/a	0.022	n/a	n/a	n/a	45	n/a	n/a	n/a
Edmonton East[2]	urban	Jan. to Dec. 1999	0.3	0.023	2.2	n/a	n/a	0.002	0.013	n/a	n/a	0.000	38	13	n/a	n/a
Edmonton Northwest[2]	urban	Jan. to Dec. 1999	0.5	0.016	2.0	n/a	n/a	n/a	0.018	n/a	n/a	n/a	41	16	10	n/a
Fort Saskatchewan[2]	small urban	Jan. to Dec. 1999	0.4	0.024	1.9	n/a	n/a	0.002	0.008	0.002	n/a	0.001	24	n/a	n/a	n/a
Buffalo Viewpoint[3]	industrial	Jan. to Dec. 1999	n/a	n/a	1.9	n/a	n/a	0.000	n/a	n/a	n/a	0.000	n/a	n/a	n/a	n/a
Fort Chipewyan[3]	rural	Jan. to Dec. 1999	n/a	0.027	n/a	n/a	n/a	0.000	0.001	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Fort McKay[3]	rural	Jan. to Dec. 1999	n/a	0.020	1.9	n/a	n/a	0.001	0.001	n/a	0.000	n/a	n/a	n/a	5	n/a
Fort McMurray (Athabasca Valley)[3]	small urban	Jan. to Dec. 1999	0.2	0.020	1.9	n/a	n/a	0.000	0.006	n/a	0.000	n/a	n/a	n/a	6	n/a
Fort McMurray (Patricia McInnes)[3]	small urban	Jan. to Dec. 1999	n/a	0.025	1.9	n/a	n/a	0.000	0.002	n/a	0.000	n/a	n/a	n/a	6	n/a
Lower Camp[3]	industrial	Jan. to Dec. 1999	n/a	n/a	2.0	n/a	n/a	0.001	n/a	n/a	n/a	0.000	n/a	n/a	n/a	n/a
Mannix[3]	industrial	Jan. to Dec. 1999	n/a	n/a	1.9	n/a	n/a	0.001	n/a	n/a	n/a	0.001	n/a	n/a	n/a	n/a
Mildred Lake[3]	industrial	Jan. to Dec. 1999	n/a	n/a	2.1	n/a	n/a	0.000	n/a	n/a	n/a	0.000	n/a	n/a	n/a	n/a
Carrot Creek[4]	rural	Jan. to Dec. 1999	n/a	0.029	n/a	n/a	n/a	0.001	0.004	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hightower Ridge[4]	background	Jan. to Dec. 1999	n/a	0.045	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		n/a	n/a
Steeper[4]	rural	Jan. to Dec. 1999	n/a	0.040	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Tomahawk[4]	rural	Jan. to Dec. 1999	n/a	0.031	n/a	n/a	n/a	0.001	0.003	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Violet Grove[4]	rural	Jan. to Dec. 1999	n/a	0.035	n/a	n/a	n/a	0.001	0.003	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sherwood Park[5]	small urban	Jan. to Dec. 1999	n/a	n/a	2.0	n/a	n/a	0.001	n/a	n/a	n/a	0.000	n/a	n/a	n/a	n/a

1 Mobile survey conducted by Alberta Environment.
2 Station operated by Alberta Environment.
3 Station operated by the Wood Buffalo Environmental Association
4 Station operated by the West Central Airshed Society.
5 Station operated by the Strathcona Industrial Association.
n/a Parameter not monitored or data not available.

* Data is from the Alberta Ambient Air Data Management System (http://www.casadata.org).

Table A.4 Typical maximum one-hour air quality parameter concentrations in Alberta*.

Air Quality Station	Station or Survey Type	Monitoring Period	CO	O_3	THC	CH_4	RHC	SO_2	NO_2	NH_3	TRS	H_2S	TSP	PM_{10}	$PM_{2.5}$	PAHs
County of Grande Prairie[1]	mobile survey	Dec. 1998 to Oct. 1999	1.0	0.064	32.4**	6.4**	29.4**	0.043	0.061	0.030	0.010	0.009	2305	1287	101	35
Caroline/Sundre area[1]	mobile survey	Apr. 1997 to Apr. 1998	0.9	0.059	2.9	2.6	0.7	0.043	0.040	n/a	0.008	0.008	52	43	17	n/a
City of Lethbridge[1]	mobile survey	Sep. 1998 to Jul. 1999	2.4	0.062	2.2	1.9	0.4	0.007	0.016	0.020	0.001	0.003	405	363	294	21
City of Medicine Hat[1]	mobile survey	May 1998 to Jan. 1999	2.8	0.062	2.6	2.3	0.4	0.029	0.080	0.027	0.001	0.004	213	135	12	35
Lethbridge area (Picture Butte, Sterling)[1]	mobile survey	Sep. 1998 to Jul. 1999	1.2	0.059	9.5	7.1**	1.6	0.004	0.013	1.364	0.054	0.054	490	298	32	11
Beaverlodge[2]	rural	Jan. to Dec. 1999	n/a	0.072	n/a	n/a	n/a	0.016	0.035	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Calgary Central[2]	urban	Jan. to Dec. 1999	7.4	0.062	5.5	n/a	n/a	n/a	0.096	n/a	n/a	n/a	n/a	250	55	n/a
Calgary East[2]	urban	Jan. to Dec. 1999	7.3	0.069	5.6	n/a	n/a	0.041	0.127	n/a	n/a	0.019	n/a	n/a	n/a	n/a
Calgary Northwest[2]	urban	Jan. to Dec. 1999	5.2	0.068	3.5	n/a	n/a	n/a	0.069	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Edmonton Central[2]	urban	Jan. to Dec. 1999	7.2	0.066	4.0	n/a	n/a	n/a	0.077	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Edmonton East[2]	urban	Jan. to Dec. 1999	2.7	0.082	16.4	n/a	n/a	0.049	0.083	n/a	n/a	0.017	n/a	320	n/a	n/a
Edmonton Northwest[2]	urban	Jan. to Dec. 1999	9.3	0.075	5.1	n/a	n/a	n/a	0.079	n/a	n/a	n/a	n/a	367	217	n/a
Fort Saskatchewan[2]	small urban	Jan. to Dec. 1999	3.9	0.097	7.0	n/a	n/a	0.041	0.085	0.070	n/a	0.005	n/a	n/a	n/a	n/a
Buffalo Viewpoint[3]	industrial	Jan. to Dec. 1999	n/a	n/a	19.9	n/a	n/a	0.072	n/a	n/a	n/a	0.061	n/a	n/a	n/a	n/a
Fort Chipewyan[3]	rural	Jan. to Dec. 1999	n/a	0.060	n/a	n/a	n/a	0.018	0.029	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Fort McKay[3]	rural	Jan. to Dec. 1999	n/a	0.060	4.0	n/a	n/a	0.094	0.029	n/a	0.005	n/a	n/a	n/a	102	n/a
Fort McMurray (Athabasca Valley)[3]	small urban	Jan. to Dec. 1999	3.9	0.066	3.5	n/a	n/a	0.047	0.047	n/a	0.003	n/a	n/a	n/a	133	n/a
Fort McMurray (Patricia McInnes)[3]	small urban	Jan. to Dec. 1999	n/a	0.059	4.7	n/a	n/a	0.069	0.047	n/a	0.004	n/a	n/a	n/a	180	n/a
Lower Camp[3]	industrial	Jan. to Dec. 1999	n/a	n/a	10.0	n/a	n/a	0.080	n/a	n/a	n/a	0.024	n/a	n/a	n/a	n/a
Mannix[3]	industrial	Jan. to Dec. 1999	n/a	n/a	7.7	n/a	n/a	0.168	n/a	n/a	n/a	0.018	n/a	n/a	n/a	n/a
Mildred Lake[3]	industrial	Jan. to Dec. 1999	n/a	n/a	13.5	n/a	n/a	0.139	n/a	n/a	n/a	0.013	n/a	n/a	n/a	n/a
Carrot Creek[4]	rural	Jan. to Dec. 1999	n/a	0.075	n/a	n/a	n/a	0.048	0.048	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hightower Ridge[4]	background	Jan. to Dec. 1999	n/a	0.086	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	46	n/a	n/a
Steeper[4]	rural	Jan. to Dec. 1999	n/a	0.071	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Tomahawk[4]	rural	Jan. to Dec. 1999	n/a	0.071	n/a	n/a	n/a	0.023	0.035	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Violet Grove[4]	rural	Jan. to Dec. 1999	n/a	0.073	n/a	n/a	n/a	0.027	0.038	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sherwood Park[5]	small urban	Jan. to Dec. 1999	n/a	n/a	4.5	n/a	n/a	0.056	n/a	n/a	n/a	0.004	n/a	n/a	n/a	n/a

1 Mobile survey conducted by Alberta Environment.
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4 Station operated by the West Central Airshed Society.
5 Station operated by the Strathcona Industrial Association.
n/a Parameter not monitored or data not available.

* Data is from the Alberta Ambient Air Data Management System (http://www.casadata.org).

** Hydrocarbon concentration was higher than the full range of the monitoring instrument for a portion of the monitoring period.

Table A.5 One-hour average air quality parameter concentrations at each monitoring site (December 1 to 6, 1998).

Monitoring Location	Date	Time (MST)	CO	O_3	THC	CH_4	RHC	SO_2	NO	NO_2	NO_x	NH_3	TRS	H_2S	TSP	PM_{10}	$PM_{2.5}$	PAH
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	µg/m³			ng/m³
Site #12	01-Dec	9:51 a.m. to 11:05 a.m.	0.2	0.014	3.2	2.7	0.5	0.001	0.016	0.009	0.025	0.002	0.001	0.001	no data			3
Site # 8		11:32 a.m. to 12:32 p.m.	0.2	0.012	2.9	2.2	0.5	0.001	0.025	0.015	0.040	0.002	0.001	0.001	no data			3
Site # 9		12:52 p.m. to 2:07 p.m.	0.1	0.018	3.3	2.4	0.7	0.000	0.016	0.008	0.024	0.001	0.000	0.001	no data			3
Site #11		3:08 p.m. to 4:07 p.m.	0.0	0.025	3.2	2.3	0.6	0.001	0.007	0.009	0.016	0.001	0.001	0.001	no data			3
Site #19		5:00 p.m. to 6:00 p.m.	0.1	0.010	3.3	2.5	0.7	0.001	0.006	0.017	0.023	0.003	0.002	0.001	no data			4
Site #18		6:29 p.m. to 7:30 p.m.	0.1	0.014	6.8	3.9	2.4	0.002	0.008	0.019	0.026	0.002	0.010	0.009	no data			5
Site #18		7:34 p.m. to 8:38 p.m.	*	*	*	*	*	0.002	*	*	*	*	0.008	0.007	no data			*
Site #22	02-Dec	9:53 a.m. to 11:00 a.m.	*	*	*	*	*	0.001	*	*	*	*	0.001	0.002	*	*	*	*
Site #21		11:15 a.m. to 12:19 a.m.	0.6	0.013	2.7	2.2	0.4	0.002	0.015	0.009	0.024	0.006	0.001	0.002	24	21	6	4
Site #23		12:39 p.m. to 1:37 p.m.	0.4	0.021	2.6	2.2	0.4	0.004	0.010	0.008	0.018	0.002	0.001	0.001	7	5	3	3
Site #20		2:43 p.m. to 3:42 p.m.	0.3	0.026	2.4	2.0	0.3	0.003	0.006	0.008	0.014	0.001	0.001	0.001	43	23	2	4
Site #16		4:12 p.m. to 5:10 p.m.	0.4	0.017	3.4	2.5	0.9	0.002	0.005	0.013	0.018	0.002	0.001	0.001	46	28	3	5
Site #13		5:34 p.m. to 6:53 p.m.	0.5	0.024	7.2	4.0	3.3	0.002	0.015	0.012	0.027	0.003	0.001	0.001	3	2	1	2
Site #14		6:58 p.m. to 8:08 p.m.	*	*	*	*	*	0.002	*	*	*	*	0.002	0.003	*	*	*	*
Site # 2	03-Dec	9:07 a.m. to 10:09 a.m.	0.4	0.014	2.4	1.9	0.3	0.001	0.008	0.008	0.017	0.002	0.001	0.002	4	3	2	2
Site #10		10:41a.m. to 11:47 a.m.	0.4	0.025	2.3	1.9	0.3	0.002	0.006	0.001	0.007	0.003	0.001	0.001	2	2	1	2
Site # 7		12:24 p.m. to 1:25 p.m.	0.4	0.024	2.2	1.8	0.3	0.003	0.006	0.001	0.007	0.002	0.001	0.001	2	2	2	2
Site # 6		1:45 p.m. to 2:58 p.m.	0.4	0.026	2.2	1.8	0.2	0.002	0.005	0.001	0.006	0.002	0.001	0.001	3	2	1	2
Site # 4		3:19 p.m. to 4:17 p.m.	*	*	*	*	*	0.002	*	*	*	*	0.001	0.001	*	*	*	*
Site # 5		4:43 p.m. to 5:41 p.m.	*	*	*	*	*	0.002	*	*	*	*	0.001	0.001	*	*	*	*
Site # 3		6:13 p.m. to 7:22 p.m.	0.5	0.021	2.3	1.9	0.3	0.001	0.006	0.003	0.009	0.001	0.001	0.001	5	3	2	2
Site # 8	04-Dec	9:10 a.m. to 10:10 a.m.	0.4	0.011	2.8	2.2	0.4	0.000	0.004	0.005	0.009	0.002	0.001	0.002	4	4	3	4
Site # 9		10:32 a.m. to 11:33 a.m.	0.2	0.008	2.9	2.2	0.5	0.000	0.013	0.011	0.024	0.002	0.001	0.001	9	8	3	4
Site #11		11:55 a.m. to 12:58 p.m.	0.3	0.014	3.9	2.8	1.0	0.001	0.007	0.005	0.012	0.002	0.001	0.001	8	6	3	3
Site #12		1:43 p.m. to 2:42 p.m.	*	*	*	*	*	0.001	*	*	*	*	0.001	0.002	*	*	*	*
Site #19		2:53 p.m. to 3:52 p.m.	*	*	*	*	*	0.001	*	*	*	*	0.001	0.002	*	*	*	*
Site #18		3:58 p.m. to 5:01 p.m.	0.2	0.015	3.3	2.5	0.7	0.000	0.007	0.011	0.018	0.002	0.001	0.001	18	15	4	3
Site #17		5:29 p.m. to 6:29 p.m.	*	*	*	*	*	0.001	*	*	*	*	0.002	0.001	*	*	*	*
Site #21	05-Dec	9:31 a.m. to 10:31 a.m.	0.4	0.017	2.5	2.0	0.2	0.001	0.004	0.006	0.010	0.002	0.001	0.002	4	4	2	2
Site #22		10:39 a.m. to 11:39 a.m.	0.3	0.022	2.3	1.9	0.2	0.000	0.003	0.003	0.006	0.002	0.001	0.001	7	5	3	2
Site #23		12:01 p.m. to 1:01 p.m.	*	*	*	*	*	0.002	*	*	*	*	0.001	0.002	*	*	*	*
Site #20		2:06 p.m. to 3:12 p.m.	*	*	*	*	*	0.001	*	*	*	*	0.001	0.001	*	*	*	*
Site #16		3:34 p.m. to 4:35 p.m.	0.4	0.018	3.2	2.5	0.5	0.001	0.005	0.013	0.018	0.002	0.001	0.001	41	20	2	3
Site #13		5:01 p.m. to 6:01 p.m.	0.5	0.021	3.6	2.5	1.0	0.001	0.003	0.010	0.013	0.002	0.001	0.001	9	7	2	4
Site #14		6:06 p.m. to 7:05 p.m.	*	*	*	*	*	0.002	*	*	*	*	0.001	0.001	*	*	*	*
Site #10	06-Dec	10:17 a.m. to 11:17 a.m.	0.6	0.004	3.9	3.0	0.8	0.000	0.027	0.014	0.040	0.003	0.001	0.002	14	12	4	12
Site # 7		11:41 a.m. to 12:41 p.m.	*	*	*	*	*	0.000	*	*	*	*	0.001	0.001	*	*	*	*
Site # 6		12:54 p.m. to 1:54 p.m.	0.2	0.026	2.2	1.8	0.2	0.003	0.007	0.004	0.011	0.001	0.000	0.000	5	2	0	2
Site # 5		2:12 p.m. to 3:13 p.m.	*	*	*	*	*	0.000	*	*	*	*	0.001	0.001	*	*	*	*
Site # 4		3:42 p.m. to 4:42 p.m.	0.1	0.038	2.0	1.7	0.1	0.000	0.002	0.000	0.002	0.002	0.001	0.000	2	1	0	1
Site # 3		5:03 p.m. to 6:02 p.m.	0.2	0.038	2.0	1.7	0.1	0.000	0.003	0.001	0.005	0.004	0.000	0.000	4	2	0	2
Site # 2		6:25 p.m. to 7:22 p.m.	0.0	0.038	2.1	1.7	0.1	0.000	0.002	0.001	0.004	0.000	0.000	0.000	3	2	0	2
One-Hour Guideline			**13.0**	**0.082**	**n/a**	**n/a**	**n/a**	**0.172**	**n/a**	**0.212**	**n/a**	**2.0**	**n/a**	**0.010**	**n/a**	**n/a**	**n/a**	**n/a**

n/a No one hour guideline.

* Indicates less than 75% of data available for one hour period due to interference from MAML generator exhaust or instrument malfunction.

no data - Indicates that analyzer was not operational for the indicated time period.

List of Air Quality Parameters

CO - carbon monoxide
O_3 - ozone
THC - total hydrocarbons
CH_4 - methane
RHC - reactive hydrocarbons
SO_2 - sulphur dioxide
NO - nitric oxide
NO_2 - nitrogen dioxide
NO_x - total oxides of nitrogen
NH_3 - ammonia
TRS - total reduced sulphur
H_2S - hydrogen sulphide
PAH - polycyclic aromatic hydrocarbons
TSP - total suspended particulates
PM_{10} - inhalable particulates
$PM_{2.5}$ - respirable particulates

Table A.6 One-hour average air quality parameter concentrations at each monitoring site (December 10 to 15, 1998).

Monitoring Location	Date	Time (MST)	CO	O_3	THC	CH_4	RHC	SO_2	NO	NO_2	NO_x	NH_3	TRS	H_2S	TSP	PM_{10}	$PM_{2.5}$	PAH
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	µg/m³			ng/m³
Site # 8	10-Dec	9:04 a.m. to 10:06 a.m.	0.1	0.036	2.1	1.8	0.3	0.000	0.002	0.000	0.002	0.002	0.001	0.002	1	0	0	1
Site # 9		10:22 a.m. to 11:24 a.m.	0.1	0.038	2.4	1.9	0.5	0.003	0.003	0.002	0.005	0.002	0.001	0.001	1	1	0	3
Site #11		12:08 p.m. to 1:09 p.m.	0.3	0.040	2.1	1.8	0.3	0.000	0.001	0.000	0.002	0.001	0.001	0.001	1	1	0	2
Site #12		1:28 p.m. to 2:27 p.m.	0.2	0.039	2.0	1.7	0.3	0.000	0.001	0.001	0.002	0.001	0.001	0.001	0	0	0	2
Site #19		2:43 p.m. to 3:42 p.m.	0.2	0.039	2.0	1.7	0.3	0.000	0.000	0.001	0.001	0.001	0.001	0.001	1	0	0	2
Site #18		3:53 p.m. to 4:54 p.m.	0.2	0.037	3.1	2.5	0.6	0.003	0.001	0.003	0.004	0.002	0.001	0.001	1	1	0	2
Site #17		5:29 p.m. to 6:29 p.m.	0.2	0.039	2.2	1.9	0.3	0.001	0.001	0.001	0.002	0.002	0.001	0.001	1	1	0	2
Site #22	11-Dec	9:15 a.m. to 10:16 a.m.	0.2	0.037	2.1	1.7	0.4	0.000	0.003	0.007	0.008	0.001	0.000	0.000	4	2	1	3
Site #21		10:29 a.m. to 11:31 a.m.	0.2	0.037	2.2	1.7	0.4	0.000	0.000	0.006	0.006	0.001	0.000	0.000	4	2	1	2
Site #23		11:55 a.m. to 12:55 p.m.	0.1	0.041	2.1	1.7	0.4	0.000	0.000	0.002	0.001	0.001	0.000	0.000	6	3	0	2
Site #20		1:43 p.m. to 2:49 p.m.	0.2	0.043	2.1	1.7	0.4	0.008	0.002	0.002	0.002	0.001	0.000	0.000	10	4	0	2
Site #16		3:22 p.m. to 4:27 p.m.	*	*	*	*	*	0.000	*	*	*	*	0.000	0.000	*	*	*	*
Site #13		4:48 p.m. to 5:54 p.m.	0.2	0.038	2.4	1.8	0.6	0.000	0.001	0.003	0.003	0.001	0.000	0.000	9	5	1	3
Site #14		6:04 p.m. to 7:07 p.m.	*	*	*	*	0.7	0.002	*	*	*	*	0.000	0.000	*	*	*	*
Site # 1	12-Dec	8:58 a.m. to 9:56 a.m.	0.4	0.017	2.3	1.8	0.5	0.001	0.000	0.003	0.002	0.001	0.000	0.000	5	2	1	2
Site # 3		10:38 a.m. to 11:56 a.m.	0.3	0.022	2.5	1.9	0.7	0.001	0.004	0.010	0.014	0.001	0.000	0.000	14	7	1	3
Site # 4		12:15 p.m. to 1:14 p.m.	0.4	0.022	2.7	2.1	0.7	0.001	0.001	0.006	0.007	0.001	0.000	0.000	12	12	2	2
Site #10		1:55 p.m. to 2:56 p.m.	*	*	*	*	*	0.004	*	*	*	*	0.000	0.001	*	*	*	*
Site # 5		3:08 p.m. to 4:09 p.m.	0.3	0.028	2.1	1.7	0.5	0.004	0.002	0.010	0.012	0.001	0.000	0.000	5	3	1	3
Site # 6		4:45 p.m. to 5:45 p.m.	0.2	0.032	2.0	1.6	0.4	0.004	0.001	0.007	0.007	0.003	0.000	0.000	4	3	1	2
Site # 2		6:36 p.m. to 7:36 p.m.	0.5	0.030	2.2	1.5	0.7	0.003	0.002	0.005	0.007	0.001	0.000	0.000	2	2	0	2
Site # 8	13-Dec	8:45 a.m. to 9:50 a.m.	0.1	0.036	2.0	1.5	0.6	0.001	no data				0.001	0.000	0	0	0	1
Site # 9		10:02 a.m. to 11:03 a.m.	0.3	0.034	2.7	1.6	1.2	0.002	no data				0.001	0.000	1	1	1	3
Site #11		11:29 a.m. to 12:29 p.m.	0.2	0.035	2.4	1.6	0.9	0.001	0.009	0.000	0.009	0.000	0.000	0.000	0	0	0	1
Site #12		1:00 p.m. to 2:01 p.m.	0.2	0.039	1.7	1.3	0.5	0.001	0.004	0.000	0.002	0.000	0.001	0.000	0	0	0	2
Site #19		2:09 p.m. to 3:22 p.m.	0.2	0.036	1.6	1.2	0.4	0.001	0.003	0.003	0.006	0.001	0.001	0.000	1	1	0	4
Site #18		3:34 p.m. to 4:35 p.m.	0.2	0.036	1.9	1.3	0.5	0.002	0.000	0.004	0.004	0.000	0.001	0.000	0	0	0	2
Site #17		5:03 p.m. to 6:13 p.m.	0.2	0.033	1.6	1.2	0.4	0.001	0.003	0.005	0.006	0.001	0.000	0.000	2	1	0	2
Site #22	14-Dec	9:15 a.m. to 10:14 a.m.	0.1	0.038	no data			0.002	0.003	0.003	0.005	0.000	0.000	0.000	2	1	0	2
Site #21		10:34 a.m. to 11:39 a.m.	0.2	0.037	no data			0.003	0.001	0.006	0.006	0.001	0.002	0.000	3	2	0	2
Site #23		12:12 p.m. to 1:15 p.m.	0.2	0.040	2.1	1.7	0.3	0.001	0.001	0.005	0.005	0.004	0.000	0.000	10	4	1	3
Site #20		1:45 p.m. to 2:45 p.m.	0.2	0.041	2.1	1.7	0.2	0.001	0.002	0.002	0.003	0.000	0.000	0.000	106	47	4	2
Site #16		3:07 p.m. to 4:07 p.m.	0.2	0.041	2.1	1.7	0.2	0.001	0.000	0.002	0.001	0.000	0.000	0.000	13	7	1	2
Site #13		4:29 p.m. to 5:35 p.m.	0.3	0.035	2.2	1.7	0.4	0.001	0.002	0.008	0.009	0.000	0.000	0.000	31	17	2	2
Site #15		5:51 p.m. to 6:50 p.m.	0.4	0.040	2.2	1.7	0.5	0.002	0.000	0.002	0.001	0.001	0.000	0.000	9	5	1	2
Site #10	15-Dec	8:30 a.m. to 9:38 a.m.	*	*	*	*	*	0.002	*	*	*	*	0.001	0.001	*	*	*	*
Site # 7		10:00 a.m. to 11:01 a.m.	*	*	*	*	*	0.001	*	*	*	*	0.000	0.000	*	*	*	*
Site # 6		11:22 a.m. to 12:22 p.m.	0.3	0.034	2.1	1.8	0.2	0.006	0.001	0.006	0.004	0.000	0.000	0.000	2	1	0	2
Site # 4		12:41 p.m. to 1:41 p.m.	0.3	0.038	2.0	1.6	0.2	0.001	0.000	0.003	0.000	0.000	0.000	0.000	2	1	0	1
Site # 5		2:00 p.m. to 3:01 p.m.	0.4	0.040	1.9	1.6	0.2	0.001	0.000	0.003	0.000	0.000	0.000	0.000	1	1	0	1
Site # 3		3:38 p.m. to 4:53 p.m.	0.6	0.041	1.9	1.6	0.2	0.001	0.001	0.003	0.001	0.001	0.000	0.000	*	*	*	2
Site # 2		5:14 p.m. to 6:14 p.m.	0.3	0.037	2.0	1.6	0.2	0.002	0.001	0.007	0.004	0.003	0.001	0.000	8	5	1	2
One-Hour Guideline			**13.0**	**0.082**	**n/a**	**n/a**	**n/a**	**0.172**	**n/a**	**0.212**	**n/a**	**2.0**	**n/a**	**0.010**	**n/a**	**n/a**	**n/a**	**n/a**

n/a No one hour guideline.

* Indicates less than 75% of data available for one hour period due to interference from MAML generator exhaust or instrument malfunction.

no data - Indicates that analyzer was not operational for the indicated time period.

List of Air Quality Parameters

CO - carbon monoxide	RHC - reactive hydrocarbons	NO_x - total oxides of nitrogen	PAH - polycyclic aromatic hydrocarbons
O_3 - ozone	SO_2 - sulphur dioxide	NH_3 - ammonia	TSP - total suspended particulates
THC - total hydrocarbons	NO - nitric oxide	TRS - total reduced sulphur	PM_{10} - inhalable particulates
CH_4 - methane	NO_2 - nitrogen dioxide	H_2S - hydrogen sulphide	$PM_{2.5}$ - respirable particulates

Table A.7 One-hour average air quality parameter concentrations at each monitoring site (April 8 to 13, 1999).

Monitoring Location	Date	Time (MST)	CO	O_3	THC	CH_4	RHC	SO_2	NO	NO_2	NO_x	NH_3	TRS	H_2S	TSP	PM_{10}	$PM_{2.5}$	PAH
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	µg/m³			ng/m³
Site # 2	08-Apr	7:22 a.m. to 8:27 a.m.	0.2	0.026	2.3	1.9	0.3	0.000	*	*	*	0.004	0.001	0.001	1	1	0	2
Site # 3		9:12 a.m. to 10:25 a.m.	0.2	0.034	2.1	1.7	0.2	0.001	0.005	0.001	0.006	0.002	0.001	0.001	4	3	1	1
Site #10		10:55 a.m. to 11:55 a.m.	0.1	0.035	2.1	1.7	0.2	0.000	0.004	0.000	0.004	0.001	0.001	0.001	7	6	1	1
Site # 9		12:11 p.m. to 1:23 p.m.	0.2	0.030	3.3	2.4	0.7	0.001	0.049	0.043	0.092	**	0.000	0.001	11	9	2	4
Site # 8		1:29 p.m. to 2:50 p.m.	0.2	0.037	2.1	1.7	0.2	0.002	0.003	0.000	0.004	0.003	0.002	0.001	14	12	2	1
Site # 6		3:11 p.m. to 4:12 p.m.	0.1	0.038	2.1	1.7	0.2	0.000	0.003	0.001	0.003	0.001	0.000	0.000	7	6	1	1
Site # 4		4:28 p.m. to 5:31 p.m.	0.1	0.038	2.1	1.7	0.2	0.000	0.003	0.000	0.003	0.001	0.000	0.000	15	13	2	2
Site # 5		5:47 p.m. to 6:45 p.m.	0.3	0.037	2.1	1.7	0.2	0.000	0.005	0.001	0.006	0.001	0.000	0.000	21	17	3	1
Site #24	09-Apr	7:55 a.m. to 8:55 a.m.	0.1	0.035	2.1	1.7	0.2	0.001	0.002	0.001	0.004	0.001	0.002	0.001	3	2	0	2
Site #22		9:11 a.m. to 10:10 a.m.	0.1	0.037	2.1	1.7	0.2	0.001	0.002	0.001	0.003	0.001	0.002	0.001	2	1	0	2
Site #21		10:21 a.m. to 11:21 a.m.	0.1	0.039	2.1	1.7	0.2	0.011	0.003	0.001	0.004	0.001	0.005	0.006	1	1	0	2
Site #23		11:58 a.m. to 12:58 p.m.	0.1	0.042	2.0	1.6	0.2	0.001	0.002	0.001	0.003	0.001	0.001	0.001	9	5	1	2
Site #25		1:15 p.m. to 2:14 p.m.	0.1	0.046	2.0	1.7	0.2	0.002	0.001	0.001	0.002	0.001	0.001	0.001	4	2	1	2
Site #20		2:39 p.m. to 3:40 p.m.	0.3	0.046	2.1	1.7	0.2	0.000	0.002	0.001	0.003	0.002	0.001	0.001	4	2	0	1
Site #17		4:05 p.m. to 5:07 p.m.	0.2	0.046	2.1	1.7	0.2	0.000	0.001	0.002	0.003	0.001	0.001	0.001	7	4	1	3
Site #11		5:53 p.m. to 6:54 p.m.	0.1	0.045	2.1	1.7	0.2	0.001	0.002	0.001	0.003	0.003	0.002	0.002	3	2	0	1
Site #19	10-Apr	8:08 a.m. to 9:08 a.m.	*	*	*	*	*	0.000	*	*	*	*	0.001	0.002	*	*	*	*
Site #12		9:24 a.m. to 10:26 a.m.	0.1	0.043	2.1	1.7	0.2	0.000	0.002	0.001	0.003	0.001	0.001	0.001	3	2	0	1
Site #18		10:53 a.m. to 11:53 a.m.	0.4	0.045	2.1	1.7	0.2	0.000	0.005	0.003	0.008	0.003	0.001	0.002	11	6	1	2
Site #16		12:52 p.m. to 1:52 p.m.	0.5	0.048	2.1	1.7	0.3	0.000	0.004	0.002	0.006	0.001	0.001	0.001	16	8	1	2
Site #26		1:59 p.m. to 3:00 p.m.	0.4	0.052	1.9	1.6	0.2	0.001	0.002	0.003	0.005	0.001	0.001	0.001	35	18	2	1
Site #14		3:33 p.m. to 4:35 p.m.	0.3	0.053	2.0	1.6	0.2	0.000	0.002	0.001	0.003	0.001	0.001	0.001	2	1	0	1
Site #13		4:45 p.m. to 5:48 p.m.	0.5	0.052	2.0	1.6	0.2	0.000	0.001	0.001	0.002	0.001	0.001	0.001	3	2	0	1
Site # 3	11-Apr	7:47 a.m. to 8:51 a.m.	0.3	0.047	2.2	1.7	0.3	0.000	0.003	0.001	0.003	0.001	0.002	0.002	15	8	1	2
Site #10		9:13 a.m. to 10:15 a.m.	0.3	0.039	2.2	1.8	0.2	0.000	0.004	0.005	0.009	0.001	0.001	0.001	53	32	3	2
Site # 8		10:43 a.m. to 11:44 a.m.	0.6	0.042	2.1	1.7	0.2	0.000	0.006	0.004	0.010	0.001	0.001	0.002	5	4	1	2
Site # 7		12:10 p.m. to 1:12 p.m.	0.3	0.052	1.9	1.6	0.2	0.000	0.001	0.001	0.002	0.001	0.001	0.001	63	24	2	1
Site # 6		1:32 p.m. to 2:32 p.m.	0.3	0.051	2.1	1.7	0.3	0.000	0.002	0.002	0.004	0.001	0.001	0.001	162	88	6	2
Site # 4		2:49 p.m. to 3:50 p.m.	0.2	0.052	2.0	1.7	0.2	0.000	0.001	0.002	0.003	0.001	0.001	0.001	24	15	2	2
Site # 5		4:01 p.m. to 5:01 p.m.	0.3	0.053	2.1	1.7	0.2	0.000	0.001	0.002	0.004	0.001	0.001	0.001	12	8	1	2
Site # 2		5:32 p.m. to 6:32 p.m.	0.3	0.049	2.0	1.6	0.2	0.000	0.002	0.003	0.005	0.001	0.001	0.001	49	34	6	2
Site #24	12-Apr	8:24 a.m. to 9:28 a.m.	0.4	0.050	2.0	1.6	0.2	0.000	0.005	0.001	0.006	0.004	0.001	0.001	9	5	0	2
Site #21		9:50 a.m. to 10:50 a.m.	0.2	0.052	2.0	1.6	0.2	0.000	0.004	0.001	0.005	0.001	0.000	0.000	3	2	0	1
Site #25		11:23 a.m. to 12:27 p.m.	0.2	0.052	1.9	1.6	0.2	0.000	0.002	0.001	0.003	0.001	0.000	0.000	4	2	0	1
Site #18		1:05 p.m. to 2:16 p.m.	0.2	0.052	1.9	1.6	0.2	0.000	0.002	0.001	0.003	0.001	0.000	0.000	14	7	1	2
Site #19		2:24 p.m. to 3:23 p.m.	0.3	0.052	2.6	1.6	0.9	0.000	0.003	0.001	0.004	0.001	0.001	0.000	217	110	8	2
Site #12		3:36 p.m. to 4:36 p.m.	0.3	0.054	1.9	1.6	0.2	0.000	0.001	0.001	0.002	0.001	0.000	0.000	4	3	1	1
Site #11		4:52 p.m. to 6:18 p.m.	0.3	0.051	2.5	2.0	0.3	0.001	0.002	0.001	0.003	0.001	0.001	0.000	60	35	4	2
Site # 9	13-Apr	7:50 a.m. to 8:51 a.m.	0.1	0.045	2.5	1.8	0.6	0.001	0.010	0.005	0.015	0.001	0.002	0.002	45	25	2	7
Site #13		9:35 a.m. to 10:35 a.m.	0.4	0.041	2.1	1.8	0.2	0.001	0.004	0.001	0.005	0.008	0.002	0.002	19	9	1	4
Site #13		10:42 a.m. to 11:43 a.m.	0.5	0.045	2.1	1.7	0.2	0.001	0.006	0.002	0.009	0.001	0.002	0.002	61	32	3	2
Site #15		*12:01 p.m. to 12:25 p.m.*	*0.1*	*0.047*	*2.0*	*1.7*	*0.2*	*0.000*	*0.002*	*0.001*	*0.003*	*0.001*	*0.001*	*0.001*	*7*	*3*	*0*	*1*
Site # 6a		1:13 p.m. to 1:43 p.m.	0.7	0.047	2.0	1.7	0.2	0.000	0.004	0.001	0.005	0.001	0.001	0.001	11	6	1	2
Site # 6		1:58 p.m. to 3:02 p.m.	0.2	0.047	2.1	1.7	0.2	0.003	0.003	0.002	0.005	0.001	0.002	0.002	7	4	1	2
Site #17		3:38 p.m. to 4:38 p.m.	0.1	0.047	2.1	1.7	0.2	0.000	0.001	0.000	0.001	0.001	0.002	0.001	94	46	4	1
Site #20		4:57 p.m. to 6:34 p.m.	0.2	0.047	2.3	1.9	0.2	0.005	0.002	0.002	0.004	0.000	0.002	0.002	29	17	2	2
One-Hour Guideline			**13.0**	**0.082**	**n/a**	**n/a**	**n/a**	**0.172**	**n/a**	**0.212**	**n/a**	**2.0**	**n/a**	**0.010**	**n/a**	**n/a**	**n/a**	**n/a**

n/a No one hour guideline.

* Indicates less than 75% of data available for one hour period due to interference from MAML generator exhaust or instrument malfunction.

** Data not available due to NO_x interference. *Data in italics* - indicates that monitoring was conducted for less than 75% of a one hour period.

no data - Indicates that analyzer was not operational for the indicated time period.

List of Air Quality Parameters

CO - carbon monoxide
O_3 - ozone
THC - total hydrocarbons
CH_4 - methane

RHC - reactive hydrocarbons
SO_2 - sulphur dioxide
NO - nitric oxide
NO_2 - nitrogen dioxide

NO_x - total oxides of nitrogen
NH_3 - ammonia
TRS - total reduced sulphur
H_2S - hydrogen sulphide

PAH - polycyclic aromatic hydrocarbons
TSP - total suspended particulates
PM_{10} - inhalable particulates
$PM_{2.5}$ - respirable particulates

Table A.8 One-hour average air quality parameter concentrations at each monitoring site (April 16 to 21, 1999).

Monitoring Location	Date	Time (MST)	CO	O_3	THC	CH_4	RHC	SO_2	NO	NO_2	NO_x	NH_3	TRS	H_2S	TSP	PM_{10}	$PM_{2.5}$	PAH
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	µg/m³			ng/m³
Site #13	16-Apr	8:38 a.m. to 9:42 a.m.	0.3	0.032	3.0	2.1	0.6	0.001	0.003	0.004	0.008	0.002	0.001	0.001	71	48	5	6
Site #14		10:28 a.m. to 11:29 a.m.	0.1	0.045	2.1	1.7	0.2	0.011	0.000	0.001	0.001	0.001	0.001	0.001	25	18	3	14
Site #16		11:52 a.m. to 12:54 p.m.	0.1	0.042	3.3	2.0	1.1	0.001	0.002	0.002	0.004	0.002	0.001	0.001	110	69	7	15
Site #20		1:25 p.m. to 2:29 p.m.	0.3	0.049	2.1	1.7	0.2	0.043	0.000	0.001	0.002	0.001	0.001	0.001	39	28	4	18
Site #25		3:02 p.m. to 4:00 p.m.	0.3	0.046	2.0	1.7	0.2	0.000	0.000	0.002	0.002	0.000	0.001	0.001	24	19	4	19
Site #21		4:33 p.m. to 5:33 p.m.	0.2	0.046	2.1	1.7	0.2	0.000	0.000	0.002	0.002	0.000	0.001	0.000	50	34	5	20
Site #24		5:55 p.m. to 6:54 p.m.	0.3	0.039	2.2	1.8	0.2	0.001	0.002	0.008	0.010	0.000	0.000	0.000	38	25	4	18
Site # 8	17-Apr	8:59 a.m. to 9:59 a.m.	0.1	0.047	2.0	1.7	0.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	14	9	1	1
Site # 9		10:16 a.m. to 11:17 a.m.	0.1	0.043	2.1	1.7	0.2	0.000	0.003	0.004	0.007	0.001	0.000	0.000	50	34	4	2
Site #10		11:38 a.m. to 12:45 p.m.	0.1	0.051	2.1	1.7	0.2	0.001	0.001	0.003	0.003	0.008	0.000	0.000	100	64	6	2
Site #11		1:01 p.m. to 2:02 p.m.	0.1	0.052	2.0	1.6	0.2	0.000	0.000	0.001	0.000	0.001	0.000	0.000	50	33	3	2
Site #17		2:24 p.m. to 3:25 p.m.	0.3	0.054	2.0	1.7	0.2	0.000	0.001	0.001	0.002	0.000	0.000	0.000	17	12	2	2
Site #18		3:46 p.m. to 4:50 p.m.	0.2	0.049	2.0	1.7	0.2	0.001	0.003	0.005	0.008	0.001	0.001	0.000	18	12	2	2
Site #19		5:17 p.m. to 6:19 p.m.	0.1	0.050	2.0	1.6	0.2	0.000	0.002	0.002	0.003	0.001	0.000	0.000	145	92	10	3
Site #12	18-Apr	7:55 a.m. to 9:07 a.m.	*	*	*	*	*	0.001	*	*	*	*	*	*	*	*	*	*
Site # 1		10:15 a.m. to 11:21 a.m.	0.2	0.025	2.8	2.2	0.4	0.000	0.000	0.002	0.002	0.022	0.002	0.002	200	137	16	2
Site # 3		12:23 p.m. to 1:32 p.m.	0.1	0.052	1.9	1.6	0.2	0.001	0.000	0.001	0.001	0.004	0.001	0.002	18	12	2	1
Site # 4		1:54 p.m. to 2:54 p.m.	0.1	0.051	2.0	1.6	0.2	0.000	0.000	0.000	0.000	0.001	0.001	0.002	23	16	3	1.4
Site # 6		3:16 p.m. to 4:18 p.m.	0.2	0.053	2.0	1.6	0.2	0.004	0.005	0.009	0.009	0.006	0.001	0.002	1099	669	63	9
Site # 5		4:36 p.m. to 5:41 p.m.	0.1	0.053	1.9	1.6	0.2	0.000	0.000	0.001	0.000	0.001	0.001	0.002	9	6	2	1
Site # 2		6:12 p.m. to 7:12 p.m.	0.2	0.052	1.9	1.6	0.2	0.000	0.000	0.001	0.000	0.001	0.001	0.001	12	8	2	2
Site #13	19-Apr	8:42 a.m. to 9:40 a.m.	0.3	0.053	2.1	1.7	0.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8	5	1	10
Site #14		9:48 a.m. to 10:48 a.m.	0.3	0.049	2.0	1.6	0.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25	14	2	12
Site #26**		11:06 a.m. to 12:22 p.m.	1.0	0.046	>13.0	3.5	>10.9	0.006	0.003	0.005	0.009	0.001	0.000	0.000	62	33	3	12
Site #16		12:34 p.m. to 1:35 p.m.	0.1	0.043	2.4	1.9	0.5	0.000	0.002	0.005	0.006	0.001	0.000	0.000	51	38	4	11
Site #20		2:14 p.m. to 3:14 p.m.	0.3	0.046	1.9	1.6	0.2	0.014	0.001	0.001	0.002	0.000	0.001	0.000	48	33	4	12
Site #17		4:47 p.m. to 5:49 p.m.	0.2	0.045	2.1	1.8	0.3	0.000	0.002	0.000	0.001	0.001	0.000	0.000	6	5	1	12
Site # 8	20-Apr	7:58 a.m. to 9:02 a.m.	0.4	0.044	2.0	1.7	0.2	0.000	0.000	0.001	0.000	0.000	0.000	0.000	38	19	2	2
Site # 5		9:17 a.m. to 10:17 a.m.	0.5	0.044	2.0	1.7	0.2	0.001	0.000	0.002	0.001	0.000	0.000	0.000	18	12	1	2
Site #10		10:33 a.m. to 11:35 a.m.	0.4	0.047	1.9	1.6	0.2	0.001	0.000	0.002	0.001	0.000	0.000	0.001	195	116	10	3
Site #12		12:06 p.m. to 1:07 p.m.	0.3	0.051	1.9	1.6	0.2	0.001	0.000	0.001	0.001	0.000	0.001	0.001	20	13	2	1
Site #19		1:25 p.m. to 2:29 p.m.	0.3	0.048	2.2	1.7	0.5	0.001	0.006	0.006	0.012	0.003	0.003	0.003	891	655	60	7
Site #18		2:36 p.m. to 3:39 p.m.	0.2	0.053	1.9	1.6	0.2	0.001	0.000	0.000	0.000	0.000	0.001	0.000	17	11	2	1
Site # 3		4:12 p.m. to 5:22 p.m.	0.2	0.044	2.5	2.4	0.3	0.001	0.087	0.023	0.091	0.004	0.001	0.001	65	47	8	2
Site # 2		5:43 p.m. to 7:06 p.m.	0.1	0.042	1.9	1.6	0.2	0.000	0.000	0.001	0.002	0.000	0.001	0.000	15	11	2	3
Site # 4	21-Apr	8:47 a.m. to 9:50 a.m.	0.2	0.044	2.0	1.7	0.2	0.001	0.000	0.001	0.001	0.003	0.000	0.001	7	4	1	2
Site # 6		10:13 a.m. to 11:27 a.m.	0.2	0.052	1.9	1.6	0.2	0.004	0.000	0.001	0.000	0.002	0.000	0.001	13	6	1	1
Site # 9		12:00 p.m. to 1:03 p.m.	0.0	0.056	1.9	1.6	0.2	0.001	0.000	0.003	0.002	0.001	0.000	0.000	9	6	1	2
Site #11		1:17 p.m. to 2:21 p.m.	0.0	0.056	2.7	1.7	1.0	0.001	0.000	0.001	0.000	0.001	0.000	0.000	38	23	3	1
Site #26		3:09 p.m. to 4:12 p.m.	0.0	0.056	2.4	1.7	0.7	0.001	0.000	0.001	0.000	0.000	0.000	0.000	21	12	2	2
One-Hour Guideline			**13.0**	**0.082**	**n/a**	**n/a**	**n/a**	**0.172**	**n/a**	**0.212**	**n/a**	**2.0**	**n/a**	**0.010**	**n/a**	**n/a**	**n/a**	**n/a**

n/a No one hour guideline.

* Indicates less than 75% of data available for one hour period due to interference from MAML generator exhaust or instrument malfunction.

no data - Indicates that analyzer was not operational for the indicated time period.

** Hydrocarbon concentrations were greater than the full range of the monitoring instrument for 25 minutes during the monitoring period.

List of Air Quality Parameters

CO - carbon monoxide
O_3 - ozone
THC - total hydrocarbons
CH_4 - methane
RHC - reactive hydrocarbons
SO_2 - sulphur dioxide
NO - nitric oxide
NO_2 - nitrogen dioxide
NO_x - total oxides of nitrogen
NH_3 - ammonia
TRS - total reduced sulphur
H_2S - hydrogen sulphide
PAH - polycyclic aromatic hydrocarbons
TSP - total suspended particulates
PM_{10} - inhalable particulates
$PM_{2.5}$ - respirable particulates

Table A.9 One-hour average air quality parameter concentrations at each monitoring site (June 15 to 20, 1999).

Monitoring Location	Date	Time (MST)	CO	O_3	THC	CH_4	RHC	SO_2	NO	NO_2	NO_x	NH_3	TRS	H_2S	TSP	PM_{10}	$PM_{2.5}$	PAH
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	µg/m³			ng/m³
Site # 8	15-Jun	8:25 a.m. to 9:28 a.m.	0.3	0.044	*	*	*	0.005	0.001	0.002	0.003	0.008	0.000	0.000	26	17	2	1
Site # 9		9:44 a.m. to 10:45 a.m.	0.2	0.047	2.0	1.7	0.2	0.002	0.001	0.002	0.002	0.004	0.000	0.000	33	22	3	2
Site #10		10:56 a.m. to 11:56 a.m.	0.2	0.054	2.0	1.7	0.2	0.001	0.000	0.001	0.001	0.004	0.000	0.000	76	46	6	2
Site #11		12:23 p.m. to 1:23 p.m.	0.3	0.056	3.2	1.7	1.3	0.001	0.000	0.001	0.000	0.004	0.000	0.000	52	35	5	3
Site #12		1:46 p.m. to 2:47 p.m.	0.2	0.053	2.1	1.8	0.2	0.002	0.001	0.002	0.002	0.001	0.000	0.000	23	15	2	5
Site #19		2:57 p.m. to 3:57 p.m.	0.2	0.043	2.9	1.9	0.9	0.003	0.025	0.013	0.036	0.008	0.002	0.002	459	304	31	13
Site #17		4:42 p.m. to 5:41 p.m.	0.3	0.055	2.0	1.7	0.2	0.001	0.000	0.001	0.000	0.000	0.000	0.000	30	19	3	2
Site #18		6:32 p.m. to 7:37 p.m.	0.2	0.055	4.1	2.2	1.8	0.003	0.001	0.001	0.001	0.000	0.001	0.001	41	25	3	1
Site #13	16-Jun	7:42 a.m. to 8:49 a.m.	0.6	0.043	2.0	1.7	0.2	0.005	0.001	0.002	0.003	0.001	0.000	0.000	85	56	7	2
Site #14		9:07 a.m. to 10:16 a.m.	*	*	*	*	*	0.007	*	*	*	*	0.000	0.000	*	*	*	*
Site #16		10:49 a.m. to 11:50 a.m.	0.1	0.054	2.0	1.7	0.2	0.006	0.000	0.002	0.001	0.000	0.000	0.000	55	37	5	2
Site #25		12:43 p.m. to 2:05 p.m.	0.2	0.057	2.0	1.7	0.2	0.004	0.001	0.001	0.002	0.001	0.001	0.001	46	31	4	1
Site #21		2:38 p.m. to 3:48 p.m.	0.2	0.055	1.9	1.7	0.2	0.021	0.001	0.002	0.002	0.000	0.002	0.001	50	34	6	2
Site #22		3:54 p.m. to 4:57 p.m.	0.1	0.055	1.9	1.7	0.2	0.004	0.001	0.003	0.004	0.001	0.001	0.000	47	32	4	2
Site #20		5:45 p.m. to 6:46 p.m.	0.1	0.041	1.9	1.6	0.2	0.006	0.001	0.001	0.002	0.000	0.001	0.000	41	27	4	1
Site # 1	17-Jun	7:43 a.m. to 8:48 a.m.	0.0	0.031	2.3	1.8	0.4	0.002	0.000	0.001	0.002	0.000	0.000	0.000	*	*	*	6
Site # 3		9:42 a.m. to 10:43 a.m.	0.41	0.038	1.9	1.6	0.2	0.001	0.000	0.000	0.000	0.000	0.000	0.000	*	*	*	1
Site # 4		11:10 a.m. to 12:17 p.m.	0.2	0.042	1.9	1.6	0.2	0.002	0.000	0.001	0.001	0.000	0.000	0.000	26	15	2	1
Site # 6		1:04 p.m. to 2:23 p.m.	0.1	0.043	1.8	1.6	0.2	0.002	0.001	0.001	0.001	0.001	0.000	0.000	17	10	1	2
Site # 7		2:50 p.m. to 3:48 p.m.	0.2	0.045	1.8	1.6	0.1	0.002	0.001	0.001	0.001	0.000	0.000	0.001	18	10	1	1
Site # 5		4:20 p.m. to 5:50 p.m.	0.1	0.045	2.3	1.6	0.6	0.002	0.001	0.002	0.002	0.000	0.000	0.000	75	44	5	1
Site # 2		6:18 p.m. to 7:19 p.m.	0.0	0.048	1.8	1.6	0.2	0.002	0.000	0.001	0.001	0.000	0.000	0.000	35	24	3	1
Site # 8	18-Jun	8:13 a.m. to 9:30 a.m.	0.1	0.050	1.8	1.6	0.2	0.002	0.002	0.003	0.004	0.000	0.000	0.000	39	23	2	2
Site # 9		9:38 a.m. to 10:48 a.m.	0.1	0.057	1.8	1.6	0.1	0.002	0.001	0.002	0.003	0.001	0.000	0.000	24	15	2	2
Site #10		10:58 a.m. to 12:10 p.m.	0.2	0.061	1.8	1.6	0.1	0.002	0.001	0.002	0.002	0.001	0.000	0.000	35	23	3	2
Site # 9		12:25 p.m. to 1:25 p.m.	0.0	0.064	2.1	1.6	0.4	0.002	0.001	0.002	0.002	0.001	0.000	0.001	40	27	4	2
Site #12		2:18 p.m. to 3:20 p.m.	0.1	0.041	1.7	1.6	0.1	0.001	0.001	0.001	0.001	0.000	0.000	0.001	28	14	2	2
Site #18		3:31 p.m. to 4:41 p.m.	0.3	0.035	1.8	1.6	0.1	0.000	0.002	0.004	0.006	0.001	0.000	0.002	13	10	2	2
Site #19		5:18 p.m. to 6:18 p.m.	0.2	0.040	2.0	1.6	0.2	0.002	0.000	0.002	0.001	0.000	0.002	0.001	7	5	1	1
Site #13	19-Jun	7:55 a.m. to 8:53 a.m.	0.0	0.019	1.9	1.7	0.1	0.002	0.010	0.005	0.014	0.003	0.000	0.000	*	*	*	2
Site #14		9:22 a.m. to 10:21 a.m.	0.0	0.026	1.9	1.7	0.1	0.002	0.001	0.002	0.003	0.000	0.000	0.000	15	7	1	1
Site #26		10:35 a.m. to 11:42 a.m.	0.0	0.026	3.3	1.9	1.3	0.004	0.001	0.001	0.001	0.000	0.000	0.000	22	9	1	2
Site #16		11:49 a.m. to 1:01 p.m.	0.0	0.026	2.5	1.9	0.5	0.002	0.007	0.003	0.010	0.001	0.000	0.000	18	7	1	2
Site #20		1:36 p.m. to 2:37 p.m.	0.1	0.038	1.9	1.7	0.1	0.028	0.000	0.002	0.002	0.000	0.001	0.001	47	20	2	2
Site #21		3:26 p.m. to 4:46 p.m.	0.2	0.032	1.9	1.8	0.1	0.009	0.004	0.002	0.005	0.000	0.003	0.004	18	9	1	4
Site #24		5:05 p.m. to 6:06 p.m.	0.0	0.039	1.9	1.7	0.1	0.002	0.000	0.000	0.001	0.000	0.001	0.001	15	8	1	1
Site # 3	20-Jun	7:37 a.m. to 8:37 a.m.	0.1	0.017	2.7	2.0	0.7	0.002	0.030	0.008	0.033	0.010	0.000	0.000	17	9	1	2
Site # 1		9:21 a.m. to 10:38 a.m.	0.1	0.024	2.0	1.7	0.2	0.001	0.003	0.003	0.004	0.002	0.000	0.000	19	10	1	2
Site # 4		11:39 a.m. to 12:38 p.m.	0.0	0.036	1.9	1.6	0.2	0.001	0.000	0.001	0.001	0.000	0.000	0.000	11	7	1	1
Site # 5		12:51 p.m. to 1:55 p.m.	0.0	0.035	1.9	1.6	0.2	0.000	0.000	0.001	0.001	0.000	0.000	0.000	34	17	2	1
Site # 6		2:20 p.m. to 3:22 p.m.	0.2	0.032	2.0	1.7	0.2	0.002	0.000	0.001	0.001	0.000	0.001	0.000	36	17	2	2
Site #2		4:27 p.m. to 5:27 p.m.	0.2	0.034	1.9	1.6	0.2	0.000	0.000	0.000	0.000	0.000	0.001	0.000	9	5	1	2
One-Hour Guideline			**13.0**	**0.082**	**n/a**	**n/a**	**n/a**	**0.172**	**n/a**	**0.212**	**n/a**	**2.0**	**n/a**	**0.010**	**n/a**	**n/a**	**n/a**	**n/a**

n/a No one hour guideline.

* Indicates less than 75% of data available for one hour period due to interference from MAML generator exhaust or instrument malfunction.

no data - Indicates that analyzer was not operational for the indicated time period.

List of Air Quality Parameters

CO - carbon monoxide
O_3 - ozone
THC - total hydrocarbons
CH_4 - methane
RHC - reactive hydrocarbons
SO_2 - sulphur dioxide
NO - nitric oxide
NO_2 - nitrogen dioxide
NO_x - total oxides of nitrogen
NH_3 - ammonia
TRS - total reduced sulphur
H_2S - hydrogen sulphide
PAH - polycyclic aromatic hydrocarbons
TSP - total suspended particulates
PM_{10} - inhalable particulates
$PM_{2.5}$ - respirable particulates

Table A.10 One-hour average air quality parameter concentrations at each monitoring site (June 23 to 28, 1999).

Monitoring Location	Date	Time (MST)	CO	O_3	THC	CH_4	RHC	SO_2	NO	NO_2	NO_x	NH_3	TRS	H_2S	TSP	PM_{10}	$PM_{2.5}$	PAH
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	µg/m^3			ng/m^3
Site #24	23-Jun	9:03 a.m. to 10:05 a.m.	0.4	0.013	2.4	2.1	0.2	0.000	0.009	0.003	0.011	0.002	0.001	0.000	3	2	0	2
Site #21		10:28 a.m. to 11:28 a.m.	0.1	0.019	2.0	1.8	0.2	0.008	0.005	0.001	0.005	0.001	0.001	0.001	2	1	0	2
Site #23		11:48 a.m. to 1:03 p.m.	0.1	0.026	2.0	1.7	0.2	0.000	0.003	0.001	0.003	0.001	0.001	0.000	32	19	2	4
Site #25		1:18 p.m. to 2:19 p.m.	0.0	0.030	1.9	1.7	0.2	0.000	0.001	0.000	0.001	0.000	0.001	0.000	4	2	0	2
Site #18		2:48 p.m. to 4:06 p.m.	0.1	0.029	2.3	2.0	0.3	0.004	0.001	0.001	0.002	0.000	0.001	0.000	7	5	1	2
Site #19		4:17 p.m. to 5:17 p.m.	0.1	0.031	2.0	1.7	0.2	0.000	0.001	0.000	0.000	0.000	0.001	0.000	7	4	1	3
Site #12		5:27 p.m. to 6:28 p.m.	0.0	0.029	1.9	1.9	0.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6	4	1	2
Site #13	24-Jun	7:51 a.m. to 8:52 a.m.	0.5	0.027	2.0	1.7	0.2	0.005	0.003	0.001	0.003	0.002	0.000	0.000	8	6	1	2
Site #13		9:12 a.m. to 10:20 a.m.	0.4	0.029	2.0	1.7	0.2	0.017	0.003	0.002	0.004	0.002	0.000	0.000	12	7	1	2
Site #14		10:51 a.m. to 12:01 p.m.	0.3	0.035	1.9	1.7	0.2	0.012	0.001	0.001	0.002	0.006	0.001	0.001	32	17	2	2
Site #13		12:09 p.m. to 1:15 p.m.	0.5	0.026	2.7	2.4	0.3	0.003	0.056	0.050	0.103	0.030	0.001	0.001	72	34	3	4
Site #15		1:30 p.m. to 2:31 p.m.	0.2	0.039	1.9	1.6	0.1	0.002	0.000	0.000	0.000	0.001	0.001	0.000	34	20	2	1
Site #26**		2:48 p.m. to 3:48 p.m.	0.2	0.038	>3.1	1.8	>1.4	0.002	0.002	0.000	0.001	0.002	0.001	0.000	22	11	1	2
Site #20		4:26 p.m. to 5:33 p.m.	0.1	0.037	1.9	1.7	0.2	0.002	0.000	0.001	0.001	0.001	0.000	0.000	56	37	4	2
Site #17		5:51 p.m. to 6:54 p.m.	0.1	0.037	1.9	1.7	0.2	0.003	0.000	0.000	0.000	0.001	0.000	0.000	18	12	2	2
Site # 3	25-Jun	8:05 a.m. to 9:06 a.m.	0.2	0.025	2.7	1.9	0.8	0.000	0.004	0.003	0.006	0.003	0.001	0.000	13	9	1	2
Site # 4		9:27 a.m. to 10:40 a.m.	0.0	0.030	2.0	1.7	0.2	0.000	0.001	0.003	0.004	0.002	0.001	0.000	67	41	4	3
Site # 5		10:52 a.m. to 11:54 a.m.	0.2	0.035	1.9	1.7	0.2	0.000	0.000	0.001	0.001	0.002	0.000	0.000	137	75	7	3
Site # 6		12:07 p.m. to 1:09 p.m.	0.0	0.037	2.0	1.8	0.2	0.000	0.000	0.001	0.001	0.002	0.000	0.000	1019	593	43	4
Site # 9		1:33 p.m. to 2:37 p.m.	0.2	0.037	2.5	1.9	0.5	0.000	0.003	0.002	0.004	0.003	0.000	0.000	11	7	1	4
Site #10		2:50 p.m. to 3:51 p.m.	0.1	0.038	1.9	1.7	0.1	0.000	0.001	0.003	0.004	0.001	0.000	0.000	2305	1287	101	4
Site #11		4:10 p.m. to 5:12 p.m.	0.1	0.036	2.0	1.7	0.2	0.000	0.000	0.002	0.001	0.001	0.000	0.000	*	*	*	2
Site # 2		5:34 p.m. to 6:31 p.m.	0.2	0.039	2.0	1.7	0.2	0.000	0.001	0.001	0.002	0.001	0.000	0.000	36	24	3	2
Site #24	26-Jun	7:55 a.m. to 9:00 a.m.	0.3	0.020	2.1	1.8	0.2	0.001	0.004	0.002	0.005	0.004	0.000	0.000	11	7	1	2
Site #21		9:34 a.m. to 10:38 a.m.	0.1	0.032	2.0	1.8	0.2	0.008	0.002	0.001	0.002	0.004	0.002	0.003	18	9	1	3
Site #25		11:15 a.m. to 12:16 p.m.	0.1	0.040	1.9	1.7	0.2	0.001	0.001	0.002	0.002	0.002	0.000	0.000	14	8	1	1
Site #17		1:23 p.m. to 2:14 p.m.	0.2	0.046	1.9	1.7	0.2	0.000	0.001	0.002	0.002	0.002	0.000	0.000	158	94	9	2
Site #20		2:41 p.m. to 3:41 p.m.	0.1	0.046	1.8	1.6	0.1	0.000	0.000	0.001	0.000	0.002	0.000	0.000	99	52	5	1
Site #18		4:11 p.m. to 5:03 p.m.	0.1	0.037	1.9	1.7	0.2	0.000	0.001	0.002	0.002	0.003	0.000	0.000	74	41	4	2
Site #19		5:41 p.m. to 6:46 p.m.	0.0	0.035	1.9	1.7	0.2	0.001	0.001	0.003	0.003	0.001	0.003	0.000	77	40	3	2
Site #13	27-Jun	7:37 a.m. to 8:38 a.m.	0.1	0.025	1.9	1.7	0.2	0.001	0.000	0.001	0.001	0.001	0.001	0.000	5	3	0	3
Site #13		8:47 a.m. to 9:47 a.m.	0.0	0.020	2.0	1.7	0.2	0.000	0.031	0.012	0.040	0.008	0.001	0.000	7	4	0	2
Site #14		10:13 a.m. to 11:15 a.m.	0.0	0.030	1.9	1.6	0.2	0.020	0.000	0.000	0.000	0.002	0.002	0.002	10	5	1	2
Site #26		11:27 a.m. to 12:27 p.m.	0.0	0.035	6.6	2.2	4.4	0.003	0.001	0.001	0.001	0.001	0.001	0.000	49	26	3	2
Site #16		12:35 p.m. to 1:35 p.m.	0.0	0.033	2.2	1.8	0.3	0.000	0.006	0.004	0.010	0.003	0.000	0.000	68	44	4	2
Site #20		1:59 p.m. to 3:20 p.m.	0.0	0.038	1.9	1.6	0.1	0.016	0.002	0.001	0.000	0.002	0.000	0.000	118	71	8	3
Site #18		4:42 p.m. to 5:53 p.m.	*	*	*	*	*	0.001	*	*	*	*	0.000	0.001	*	*	*	*
Site # 4	28-Jun	7:46 a.m. to 8:48 a.m.	0.1	0.028	1.8	1.5	0.2	0.000	0.000	0.000	0.000	0.001	0.000	0.001	11	6	1	1
Site # 6		9:09 a.m. to 10:10 a.m.	0.3	0.031	1.9	1.6	0.2	0.004	0.002	0.002	0.003	0.002	0.000	0.000	351	194	16	2
Site # 5		10:20 a.m. to 11:20 a.m.	0.1	0.034	1.9	1.6	0.1	0.000	0.000	0.000	0.000	0.001	0.000	0.000	13	9	2	1
Site # 9		11:39 a.m. to 12:39 p.m.	0.2	0.034	3.6	1.7	1.8	0.001	0.004	0.003	0.006	0.002	0.000	0.000	14	9	1	3
Site #10		1:03 p.m. to 2:04 p.m.	0.0	0.032	1.8	1.5	0.2	0.000	0.001	0.001	0.001	0.002	0.000	0.000	54	30	4	4
Site #11		2:22 p.m. to 3:24 p.m.	0.0	0.032	2.2	1.7	0.4	0.000	0.001	0.001	0.001	0.002	0.000	0.000	44	24	3	2
Site # 2		3:47 p.m. to 4:47 p.m.	0.1	0.032	1.8	1.6	0.1	0.000	0.000	0.001	0.000	0.001	0.000	0.000	71	39	4	5
One-Hour Guideline			**13.0**	**0.082**	**n/a**	**n/a**	**n/a**	**0.172**	**n/a**	**0.212**	**n/a**	**2.0**	**n/a**	**0.010**	**n/a**	**n/a**	**n/a**	**n/a**

n/a No one hour guidelin >Indicates the pollutant exceeded the range of the instrument

* Indicates less than 75% of data available for one hour period due to interference from MAML generator exhaust or instrument malfunction.

** Hydrocarbon concentrations were greater than the full range of the monitoring instrument for two minutes during the monitoring period.

List of Air Quality Parameters

CO - carbon monoxide
O_3 - ozone
THC - total hydrocarbons
CH_4 - methane
RHC - reactive hydrocarbons
SO_2 - sulphur dioxide
NO - nitric oxide
NO_2 - nitrogen dioxide
NO_x - total oxides of nitrogen
NH_3 - ammonia
TRS - total reduced sulphur
H_2S - hydrogen sulphide
PAH - polycyclic aromatic hydrocarbons
TSP - total suspended particulates
PM_{10} - inhalable particulates
$PM_{2.5}$ - respirable particulates

Table A.11 One-hour average air quality parameter concentrations at each monitoring site (October 14 to 19, 1999).

Monitoring Location	Date	Time (MST)	CO	O_3	THC	CH_4	RHC	SO_2	NO	NO_2	NO_x	NH_3	TRS	H_2S	TSP	PM_{10}	$PM_{2.5}$	PAH
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	µg/m³			ng/m³
Site # 1	14-Oct	8:19 a.m. to 9:19 a.m.	0.2	0.030	2.4	1.9	0.5	0.000	0.006	0.009	0.015	0.002	0.000	0.000	no data			1
Site #23		10:59 a.m. to 12:03 p.m.	0.7	0.031	1.9	1.6	0.3	0.000	0.002	0.001	0.002	0.001	0.000	0.000	no data			0
Site #27		12:11 p.m. to 1:14 p.m.	0.4	0.031	2.1	1.7	0.4	0.000	0.001	0.001	0.002	0.001	0.000	0.001	no data			2
Site #28		1:31 p.m. to 3:01 p.m.	0.2	0.031	1.8	1.5	0.3	0.003	0.000	0.001	0.001	0.001	0.000	0.001	no data			0
Site #24		3:33 p.m. to 4:33 p.m.	0.1	0.031	1.9	1.6	0.3	0.000	0.000	0.000	0.001	0.001	0.001	0.002	no data			0
Site #21		4:56 p.m. to 6:11 p.m.	0.2	0.027	2.1	1.7	0.3	0.012	0.001	0.003	0.004	0.001	0.002	0.004	no data			1
Site # 3	15-Oct	8:21 a.m. to 9:23 a.m.	0.1	0.018	4.1	3.2	1.1	0.000	0.064	0.017	0.076	0.014	0.000	0.001	no data			0
Site # 5		9:44 a.m. to 10:44 a.m.	0.1	0.031	1.9	1.6	0.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	no data			0
Site # 6		10:57 a.m. to 12:02 p.m.	0.1	0.032	1.9	1.6	0.3	0.000	0.000	0.001	0.001	0.000	0.000	0.000	no data			0
Site #10		12:27 p.m. to 1:28 p.m.	0.1	0.032	1.9	1.5	0.3	0.000	0.000	0.000	0.001	0.000	0.000	0.001	no data			0
Site # 8		1:44 p.m. to 2:44 p.m.	0.0	0.033	1.9	1.5	0.3	0.000	0.000	0.000	0.000	0.000	0.000	0.001	no data			0
Site # 9		2:58 p.m. to 3:59 p.m.	0.7	0.026	3.1	2.2	0.9	0.001	0.049	0.061	0.093	0.012	0.000	0.002	no data			11
Site #11		4:19 p.m. to 5:23 p.m.	0.1	0.031	2.3	1.9	0.4	0.000	0.000	0.000	0.001	0.000	0.000	0.001	no data			2
Site # 2		6:21 p.m. to 7:20 p.m.	0.0	0.027	1.9	1.6	0.3	0.000	0.001	0.003	0.003	0.000	0.000	0.000	no data			2
Site #13	16-Oct	8:39 a.m. to 9:40 a.m.	0.0	0.027	2.0	1.7	0.3	0.000	0.000	0.002	0.002	0.000	0.000	0.000	no data			3
Site #26**		10:13 a.m. to 11:12 a.m.	0.2	0.031	>32.4	>5.3	>29.4	0.007	0.002	0.001	0.004	0.001	0.000	0.000	no data			0
Site #26***		11:13 a.m. to 12:21 p.m.	0.2	0.024	>32.2	>6.4	>28.1	0.008	0.021	0.010	0.030	0.001	0.000	0.000	no data			0
Site #16		12:30 p.m. to 1:37 p.m.	0.0	0.031	2.7	2.0	0.8	0.000	0.003	0.002	0.005	0.001	0.000	0.000	no data			1
Site #20		2:03 p.m. to 3:07 p.m.	0.1	0.033	1.9	1.6	0.3	0.023	0.000	0.001	0.001	0.000	0.000	0.000	no data			0
Site #18		4:34 p.m. to 5:36 p.m.	0.3	0.030	4.5	3.9	0.8	0.016	0.002	0.003	0.005	0.000	0.000	0.001	no data			0
Site #19		5:45 p.m. to 6:44 p.m.	0.2	0.031	2.0	1.6	0.4	0.002	0.002	0.003	0.003	0.003	0.000	0.001	no data			0
Site#12	17-Oct	8:12 a.m. to 9:12 a.m.	0.0	0.033	2.1	1.9	0.1	0.002	0.001	0.001	0.002	0.003	0.000	0.000	no data			0
Site #17		9:43 a.m. to 10:45 a.m.	0.0	0.035	1.9	1.7	0.1	0.002	0.001	0.001	0.002	0.003	0.000	0.000	no data			1
Site #27		11:24 a.m. to 12:24 p.m.	0.0	0.036	1.8	1.7	0.1	0.002	0.003	0.002	0.005	0.000	0.000	0.000	no data			35
Site #23		12:46 p.m. to 1:46 p.m.	0.2	0.036	1.8	1.6	0.1	0.001	0.000	0.001	0.000	0.002	0.000	0.000	no data			0
Site #28		2:03 p.m. to 3:07 p.m.	0.3	0.035	1.8	1.6	0.1	0.002	0.001	0.001	0.001	0.000	0.000	0.000	no data			0
Site #21		3:30 p.m. to 4:32 p.m.	0.1	0.033	1.9	1.7	0.1	0.006	0.001	0.002	0.002	0.000	0.002	0.004	no data			0
Site #22		4:38 p.m. to 5:38 p.m.	0.1	0.033	1.9	1.7	0.1	0.004	0.000	0.001	0.001	0.000	0.001	0.001	no data			0
Site # 1	18-Oct	8:24 a.m. to 9:25 a.m.	0.0	0.007	2.1	1.9	0.1	0.000	0.011	0.005	0.016	0.000	0.000	0.000	no data			2
Site # 3		10:14 a.m. to 11:17 a.m.	0.0	0.026	3.0	2.4	0.6	0.001	0.033	0.013	0.044	0.003	0.000	0.000	no data			0
Site # 6		11:58 a.m. to 12:57 p.m.	0.0	0.036	1.8	1.6	0.1	0.001	0.001	0.002	0.003	0.001	0.000	0.000	no data			1
Site # 9		1:14 p.m. to 2:13 p.m.	0.0	0.038	3.1	1.6	1.4	0.002	0.000	0.000	0.000	0.001	0.000	0.000	no data			0
Site #11		2:34 p.m. to 3:36 p.m.	0.0	0.039	1.9	1.7	0.2	0.002	0.000	0.001	0.001	0.000	0.000	0.000	no data			1
Site #10		3:47 p.m. to 4:47 p.m.	0.0	0.040	1.8	1.6	0.1	0.001	0.001	0.003	0.004	0.000	0.000	0.001	no data			5
Site # 4		5:05 p.m. to 6:04 p.m.	0.0	0.036	1.7	1.6	0.1	0.001	0.000	0.000	0.000	0.000	0.000	0.001	no data			0
Site # 2		6:51 p.m. to 7:50 p.m.	0.1	0.030	1.8	1.6	0.1	0.001	0.000	0.002	0.003	0.000	0.000	0.001	no data			2
Site #20	19-Oct	8:31 a.m. to 9:36 a.m.	0.0	0.028	1.7	1.4	0.2	0.000	0.001	0.002	0.001	0.001	0.000	0.000	no data			0
Site #26		10:05 a.m. to 11:17 a.m.	0.0	0.030	8.3	2.4	5.9	0.000	0.000	0.001	0.000	0.002	0.000	0.000	no data			0
Site #16		11:29 a.m. to 12:28 p.m.	0.1	0.030	2.4	1.7	0.7	0.000	0.001	0.002	0.002	0.000	0.000	0.000	no data			0
Site #17		1:00 p.m. to 2:00 p.m.	0.2	0.029	1.7	1.4	0.3	0.000	0.000	0.000	0.000	0.000	0.000	0.001	no data			1
Site #18		2:48 p.m. to 3:47 p.m.	0.0	0.026	4.9	4.0	0.9	0.009	0.001	0.002	0.003	0.001	0.000	0.001	no data			0
Site #19		3:56 p.m. to 4:58 p.m.	0.0	0.028	2.0	1.4	0.6	0.000	0.003	0.001	0.004	0.002	0.000	0.000	no data			0
Site #12		5:09 p.m. to 6:09 p.m.	0.0	0.027	1.7	1.4	0.3	0.000	0.000	0.000	0.000	0.001	0.000	0.000	no data			0
One-Hour Guideline			**13.0**	**0.082**	**n/a**	**n/a**	**n/a**	**0.172**	**n/a**	**0.212**	**n/a**	**2.0**	**n/a**	**0.010**	**n/a**			**n/a**

n/a No one hour guidelin >Indicates the pollutant exceeded the range of the instrument

* Indicates less than 75% of data available for one hour period due to interference from MAML generator exhaust or instrument malfunction.

>Indicates the pollutant exceeded the range of the instrument.

Data in italics - indicates that monitoring was conducted for less than 75% of a one hour period.

**Hydrocarbon concentrations were greater than the full range of the instrument for 13 minutes during the monitoring period.

***Hydrocarbon concentrations were greater than the full range of the instrument for 11 minutes during the monitoring period.

List of Air Quality Parameters

CO - carbon monoxide
O_3 - ozone
THC - total hydrocarbons
CH_4 - methane
RHC - reactive hydrocarbons
SO_2 - sulphur dioxide
NO - nitric oxide
NO_2 - nitrogen dioxide
NO_x - total oxides of nitrogen
NH_3 - ammonia
TRS - total reduced sulphur
H_2S - hydrogen sulphide
PAH - polycyclic aromatic hydrocarbons
TSP - total suspended particulates
PM_{10} - inhalable particulates
$PM_{2.5}$ - respirable particulates

Table A.12 One-hour average air quality parameter concentrations at each monitoring site (October 22 to 27, 1999).

Monitoring Location	Date	Time (MST)	CO	O_3	THC	CH_4	RHC	SO_2	NO	NO_2	NO_x	NH_3	TRS	H_2S	TSP	PM_{10}	$PM_{2.5}$	PAH
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	$\mu g/m^3$			ng/m^3
Site #24	22-Oct	9:25 a.m. to 10:25 a.m.	0.1	0.005	1.9	1.6	0.3	0.000	0.008	0.005	0.012	0.010	0.001	0.002	*	*	*	2
Site #21		10:47 a.m. to 11:53 a.m.	0.1	0.010	2.1	1.7	0.3	0.006	0.009	0.004	0.013	0.005	0.002	0.003	12	6	1	1
Site #23		12:15 p.m. to 1:15 p.m.	0.0	0.020	2.0	1.6	0.3	0.000	0.014	0.005	0.016	0.008	0.000	0.000	18	11	1	*
Site #20		2:05 p.m. to 3:05 p.m.	0.0	0.032	1.7	1.4	0.2	0.000	0.001	0.000	0.001	0.005	0.000	0.000	14	7	1	*
Site #18		3:58 p.m. to 4:58 p.m.	0.0	0.016	2.1	1.7	0.3	0.000	0.003	0.003	0.006	0.005	0.001	0.000	6	4	1	1
Site #19		5:19 p.m. to 6:21 p.m.	0.2	0.003	2.6	2.0	0.5	0.002	0.017	0.013	0.029	0.012	0.004	0.004	32	22	3	9
Site # 3**	23-Oct	8:08 a.m. to 9:09 a.m.	0.0	0.010	>6.8	>3.2	>3.9	0.000	0.011	0.004	0.014	0.005	0.001	0.000	9	7	2	0
Site #10		9:39 a.m. to 10:40 a.m.	0.2	0.008	2.4	2.1	0.3	0.001	0.020	0.006	0.026	0.004	0.002	0.000	49	28	4	7
Site # 6		11:04 a.m. to 12:04 p.m.	0.1	0.024	2.2	1.7	0.3	0.000	0.004	0.005	0.009	0.000	0.001	0.000	12	8	2	1
Site # 4		12:20 p.m. to 1:19 p.m.	0.0	0.024	2.1	1.7	0.3	0.000	0.003	0.002	0.005	0.000	0.001	0.000	6	5	2	0
Site # 5		1:31 p.m. to 2:31 p.m.	0.0	0.027	2.1	1.6	0.3	0.000	0.003	0.003	0.006	0.000	0.001	0.000	9	7	2	1
Site # 9		2:44 p.m. to 3:44 p.m.	0.1	0.027	2.0	1.5	0.3	0.000	0.003	0.003	0.006	0.000	0.001	0.000	12	8	2	0
Site #12		4:14 p.m. to 5:14 p.m.	0.1	0.021	2.2	1.7	0.3	0.000	0.001	0.005	0.007	0.000	0.001	0.000	10	7	2	1
Site # 2		5:30 p.m. to 6:30 p.m.	0.1	0.029	1.9	1.5	0.2	0.000	0.000	0.004	0.004	0.000	0.001	0.000	*	*	*	0
Site #13	24-Oct	8:06 a.m. to 9:06 a.m.	0.1	0.032	2.2	1.8	0.3	0.000	0.009	0.005	0.012	0.006	0.000	0.000	13	6	1	0
Site #13		9:18 a.m. to 10:18 a.m.	0.2	0.034	1.9	1.5	0.2	0.000	0.000	0.000	0.001	0.003	0.000	0.000	7	4	1	0
Site #14		10:33 a.m. to 11:33 a.m.	0.2	0.034	1.9	1.5	0.2	0.000	0.001	0.006	0.007	0.002	0.000	0.000	32	15	2	0
Site #26		11:43 a.m. to 12:43 p.m.	0.3	0.036	8.0	1.9	5.5	0.001	0.002	0.000	0.001	0.004	0.000	0.000	20	10	1	0
Site #16		12:52 p.m. to 1:52 p.m.	0.2	0.034	2.2	1.6	0.4	0.000	0.006	0.004	0.009	0.003	0.000	0.000	70	38	4	0
Site #20		2:12 p.m. to 3:12 p.m.	0.2	0.036	2.1	1.6	0.3	0.000	0.001	0.000	0.001	0.001	0.000	0.000	32	19	2	0
Site # 9		3:52 p.m. to 4:52 p.m.	0.2	0.035	2.3	1.5	0.6	0.000	0.001	0.001	0.002	0.001	0.000	0.000	3	2	0	1
Site #11		5:18 p.m. to 6:18 p.m.	0.1	0.033	2.1	1.6	0.3	0.000	0.001	0.001	0.001	0.001	0.000	0.000	9	6	1	1
Site # 1	25-Oct	8:16 a.m. to 9:16 a.m.	0.2	0.016	2.2	1.7	0.2	0.001	0.003	0.002	0.005	0.006	0.000	0.000	42	20	2	1
Site #24		10:41 a.m. to 11:41 a.m.	0.1	0.029	2.1	1.6	0.3	0.005	0.001	0.002	0.003	0.004	0.001	0.000	28	14	1	0
Site #21		12:03 p.m. to 1:11 p.m.	0.2	0.031	2.0	1.5	0.2	0.008	0.001	0.002	0.002	0.002	0.001	0.001	14	8	1	0
Site #23		1:28 p.m. to 2:28 p.m.	0.3	0.026	2.0	1.5	0.3	0.004	0.004	0.006	0.010	0.002	0.000	0.000	62	37	4	1
Site #25		2:57 p.m. to 3:57 p.m.	0.1	0.029	1.8	1.5	0.2	0.004	0.000	0.002	0.002	0.002	0.000	0.000	50	26	2	1
Site #17		4:19 p.m. to 5:19 p.m.	0.2	0.022	1.9	1.5	0.3	0.002	0.001	0.004	0.005	0.006	0.000	0.000	45	24	2	1
Site #12		5:41 p.m. to 6:42 p.m.	*	*	*	*	*	0.003	*	*	*	*	0.000	0.000	*	*	*	*
Site # 3	26-Oct	8:11 a.m. to 9:11 a.m.	0.1	0.024	3.1	2.0	0.9	0.003	0.064	0.026	0.080	*	0.001	0.001	*	*	*	0
Site #10		9:47 a.m. to 10:47 a.m.	0.1	0.034	1.8	1.5	0.2	0.001	0.001	0.000	0.001	0.004	0.000	0.000	2	1	0	0
Site # 6		11:06 a.m. to 12:06 p.m.	0.2	0.032	1.9	1.6	0.2	0.008	0.002	0.003	0.004	0.003	0.001	0.000	4	2	0	1
Site #11		12:47 p.m. to 1:47 p.m.	0.1	0.034	2.1	1.7	0.3	0.001	0.001	0.001	0.001	0.003	0.000	0.000	4	2	1	0
Site #19		2:07 p.m. to 3:07 p.m.	0.1	0.035	2.0	1.5	0.3	0.001	0.000	0.000	0.000	0.002	0.000	0.000	5	3	0	0
Site # 1		4:24 p.m. to 5:24 p.m.	0.2	0.027	4.7	3.9	0.9	0.004	0.071	0.044	0.083	*	0.000	0.000	11	7	1	0
Site # 2		5:54 p.m. to 6:54 p.m.	0.1	0.032	1.9	1.5	0.2	0.001	0.000	0.001	0.000	0.002	0.000	0.000	6	3	1	0
Site #13	27-Oct	8:38 a.m. to 9:38 a.m.	0.0	0.027	2.3	1.8	0.5	0.003	0.008	0.004	0.011	0.007	0.001	0.001	no data			1
Site #13		9:45 a.m. to 10:45 a.m.	0.1	0.029	2.0	1.6	0.3	0.003	0.003	0.003	0.005	0.005	0.001	0.001	no data			2
Site #14		11:04 a.m. to 12:04 p.m.	0.3	0.033	2.0	1.6	0.3	0.004	0.003	0.004	0.007	0.003	0.003	0.002	14	8	1	2
Site #26		12:16 p.m. to 1:16 p.m.	0.3	0.037	5.7	2.5	3.0	0.005	0.002	0.001	0.002	0.002	0.001	0.000	43	22	2	0
Site #16		1:25 p.m. to 2:35 p.m.	0.3	0.033	1.9	1.6	0.3	0.003	0.001	0.003	0.003	0.003	0.001	0.000	96	47	4	1
Site #17		2:59 p.m. to 3:59 p.m.	0.1	0.028	1.9	1.5	0.2	0.001	0.000	0.002	0.002	0.000	0.001	0.000	37	21	2	0
Site #19		4:32 p.m. to 5:32 p.m.	0.2	0.019	2.6	1.8	0.7	0.003	0.020	0.018	0.038	0.000	0.003	0.002	126	61	4	12
One-Hour Guideline			**13.0**	**0.082**	**n/a**	**n/a**	**n/a**	**0.172**	**n/a**	**0.212**	**n/a**	**2.0**	**n/a**	**0.010**	**n/a**	**n/a**	**n/a**	**n/a**

n/a No one hour guideline.

* Indicates less than 75% of data available for one hour period due to interference from MAML generator exhaust or instrument malfunction.

no data - Indicates that analyzer was not operational for the indicated time period.

** Hydrocarbon concentrations were greater than the full range of the monitoring instrument (20.0 ppm) for two minutes during the monitoring period, after which the upper range was changed to 50.0 ppm.

List of Air Quality Parameters

CO - carbon monoxide	RHC - reactive hydrocarbons	NO_x - total oxides of nitrogen	PAH - polycyclic aromatic hydrocarbons
O_3 - ozone	SO_2 - sulphur dioxide	NH_3 - ammonia	TSP - total suspended particulates
THC - total hydrocarbons	NO - nitric oxide	TRS - total reduced sulphur	PM_{10} - inhalable particulates
CH_4 - methane	NO_2 - nitrogen dioxide	H_2S - hydrogen sulphide	$PM_{2.5}$ - respirable particulates

Table A.13 Weather conditions, monitoring distance from the source and MAML operator's comments (December 1 to 6, 1998).

Monitoring Location	Date	Time (M.S.T.)	Temp.	RH	WSP	WDR	Approximate Distance from the source	Cloud	Operator's Comments
			oC	%	km/h				
Site #12	1-Dec	9:51 a.m. to 11:05 a.m.	-14	84	4	WSW	800m	no data	Stop 1/2 mi. east of L-14 on Rge Rd 92
Site # 8		11:32 a.m. to 12:32 p.m.	-8	76	3	ESE	1.0 km	no data	Stop 1/2 mi W of Rge Rd 113 on Twp Rd 744 at entrance to ESSO Resource LSD 03-23-74-11-W6
Site # 9		12:52 p.m. to 2:07 p.m.	-9	78	3	SSW	2.0 km	no data	Stop west of L-10 (Rge Rd 113 and Twp Rd 741)
Site #11		3:08 p.m. to 4:07 p.m.	-12	86	13	NE	1.6 km	no data	Stop 1 mi. W of L-12 on Twp Rd 734.
Site #19		5:00 p.m. to 6:00 p.m.	-17	91	5	N	50m	no data	Stop 1/2 mi. down &1 mi. W of L-20
Site #18		6:29 p.m. to 7:30 p.m.	-13	93	2	WSW	800m	no data	Stop 3/4 mi. down on Rge Rd 90 from Twp Rd 735. 6:32 pm-Elevated RHC&H2S readings.
Site #18		7:34 p.m. to 8:38 p.m.	-12	91	2	SW	650m	no data	Stop 20-30 m E of Rge Rd 90 on Twp Rd 734
Site #22	2-Dec	9:53 a.m. to 11:00 a.m.	-10	96	1	WSW	5.6 km	0%	Stop at L-24 on N side of hwy.about 30 m
Site #21		11:15 a.m. to 12:19 a.m.	-8	91	4	SW	300m NE	no data	Stop about 300m NE of main stack at L-23
Site #23		12:39 p.m. to 1:37 p.m.	-6	79	5	NW	Sexsmith	no data	Stop on S edge of town at LSD 01-24-073-06-W6
Site #20		2:43 p.m. to 3:42 p.m.	-2	75	3	W	900m	no data	Stop 1/2 mi. down from L-22 and face SW
Site #16		4:12 p.m. to 5:10 p.m.	-12	94	4	NW	2.0 km	no data	200m W of Rge Rd 90 on Twp Rd 750 ~ 1/2 mi. S of L-17.
Site #13		5:34 p.m. to 6:53 p.m.	-6	94	3	SSE	100m	no data	Stop at L-15
Site #14		6:58 p.m. to 8:08 p.m.	-6	95	1	S	500m	no data	Stop 1/4 mi. W of L-16 on Twp Rd 752
Site # 2	3-Dec	9:07 a.m. to 10:09 a.m.	-10	94	5	NW	Beaverlodge	no data	About 1 km NW of Agri. Stn
Site #10		10:41a.m. to 11:47 a.m.	-8	92	6	WNW	Hythe	no data	NW end of L-11 from Hwy2 at edge of county
Site # 7		12:24 p.m. to 1:25 p.m.	-5	74	4	NW	Transboundary	no data	Face W about 1.5 mi. from Hwy2 at edge of county.
Site # 6		1:45 p.m. to 2:58 p.m.	-8	84	6	WNW	1.2 km	no data	Stop 1/4 mi. S of Twp Rd 742 on Rge Rd 125.
Site # 4		3:19 p.m. to 4:17 p.m.	-11	88	1	W	Lymburn	no data	Twp Rd 734 & Rge Rd 123 SO_2 likely due to school bus passing by.
Site # 5		4:43 p.m. to 5:41 p.m.	-11	94	1	W	Brainard	no data	Stop at Rge Rd 115 & Twp Rd 740
Site # 3		6:13 p.m. to 7:22 p.m.	-9	93	3	SSW	1.3 km	no data	Face N at Rge Rd 115 & Twp Rd 723 at L-3 site.
Site # 8	4-Dec	9:10 a.m. to 10:10 a.m.	-12	93	2	WNW	1.0 km	80%	L-9 Face Nat Twp Rd 744 &Rge Rd 113.5
Site # 9		10:32 a.m. to 11:33 a.m.	-13	92	2	NE	900m	70%	1/4 mi. S of Sec. 59 on Rge Rd 113 (L-10)
Site #11		11:55 a.m. to 12:58 p.m.	-11	93	2	SW	500m	60%	1/4 mi. from L-12 on Rge Rd 103
Site #12		1:43 p.m. to 2:42 p.m.	-9	84	3	SE	300m	50%	Entrance to L-14 ~ 300m from stack, face N.
Site #19		2:53 p.m. to 3:52 p.m.	-9	88	2	S	40m	50%	Stop 250m S of sec. 672 at L-20
Site #18		3:58 p.m. to 5:01 p.m.	-11	95	1	WSW	2.0 km	no data	Stop 3/4 mi. from sec. 672 on Rge Rd 85 & 1/4 mi. from road to L-19 Note: 17:03 pass piles of brush burning on side of road. Check particulates data.
Site #17		5:29 p.m. to 6:29 p.m.	-14	94	2	W	800m	no data	Stop 1 mi. down on Rge Rd 90 and face S. Some fog.
Site #21	5-Dec	9:31 a.m. to 10:31 a.m.	-11	88	2	N	700m	100%	Stop on E side adjacent to L-23
Site #22		10:39 a.m. to 11:39 a.m.	-8	80	2	NW	5.6 km	90%	In front of Teepee Creek School (L-24) Face N.
Site #23		12:01 p.m. to 1:01 p.m.	-5	80	2	SSW	Sexsmith	100%	Stop on the N end at the city limits.L25
Site #20		2:06 p.m. to 3:12 p.m.	-2	70	1	SW	400m	no data	Stop about 1/4 mi. N of L-22 stack.
Site #16		3:34 p.m. to 4:35 p.m.	-6	82	2	SW	430m	no data	Stop 1/4 mi. N of L-17 on Rge Rd 90 Pick-up some SO_2 between L-16 and L-15
Site #13		5:01 p.m. to 6:01 p.m.	-7	91	4	WNW	800m	no data	Stop 1/2 mi. N of L-15 on Rge Rd 94
Site #14		6:06 p.m. to 7:05 p.m.	-6	81	2	SW	2.0 km	no data	Stop 200m E of Rge Rd 94
Site #10	6-Dec	10:17 a.m. to 11:17 a.m.	-13	79	1	W	Hythe	90%	Stop in N side of Hythe (L-11)
Site # 7		11:41 a.m. to 12:41 p.m.	0	67	3	SW	Transboundary	80%	Grande Prairie corporate limits.
Site # 6		12:54 p.m. to 1:54 p.m.	0	66	4	WNW	200m NE	50%	Stop 200m NE of L-7 stack.
Site # 5		2:12 p.m. to 3:13 p.m.	0	61	3	SSW	Brainard	40%	Stop just before the bend to the E on Brainard Lake on Rge Rd 122
Site # 4		3:42 p.m. to 4:42 p.m.	0	56	17	WSW	Lymburn	30%	face S for L-4
Site # 3		5:03 p.m. to 6:02 p.m.	-2	58	6	WSW	1.6 km	no data	Stop at Twp Rd 724 & Rge Rd 115 for L-3
Site # 2		6:25 p.m. to 7:22 p.m.	-4	63	6	SW	Beaverlodge	no data	L-2

Table A.14 Weather conditions, monitoring distance from the source and MAML operator's comments (December 10 to 15, 1998).

Monitoring Location	Date	Time (M.S.T.)	Temp.	RH	WSP	WDR	Approximate Distance from the source	Cloud	Operator's Comments
			oC	%	km/h				
Site # 8	10-Dec	9:04 a.m. to 10:06 a.m.	4	79	19	WSW	Martin Lake	100%	Stop on Twp Rd 744 1/2 mi W of Rge rd 113
Site # 9		10:22 a.m. to 11:24 a.m.	4	75	21	WSW	150m	95%	Stop on Rge Rd 112 downwind of UPR Knopcik
Site #11		12:08 p.m. to 1:09 p.m.	4	70	34	WSW	100m	40%	Stop on Rge Rd 103 downwind of Rigel Knopcik
Site #12		1:28 p.m. to 2:27 p.m.	4	75	27	WSW	1.2km	20%	Stop on Rge Rd 92 downwind of Rigel Battery
Site #19		2:43 p.m. to 3:42 p.m.	4	72	20	WSW	1.5km	10%	Stop on Rge Rd 84 S of #672
Site #18		3:53 p.m. to 4:54 p.m.	3	77	16	SW	1.5km	5%	Stop at corner of Rge Rd 8-5 & Twp Rd 73-4
Site #17		5:29 p.m. to 6:29 p.m.	2	70	26	WSW	800m	0%	Stop on Rge Rd 85 N of Hwy 59 dark but clear
Site #22	11-Dec	9:15 a.m. to 10:16 a.m.	-1	73	10	WSW	Teepee Creek	90%	Stop at Teepee Creek fire hall
Site #21		10:29 a.m. to 11:31 a.m.	-2	74	9	WSW	800m	90%	Stop on Rge Rd 4-1.5 mi. downwind from Talisman Teepee Creek gas plant
Site #23		11:55 a.m. to 12:55 p.m.	0	68	9	WSW	Sexsmith	80%	Rge Rd 61, 1 mi. S of Hwy 59
Site #20		1:43 p.m. to 2:49 p.m.	1	59	7	S	2km	60%	Hwy 724 & equivalent of Rge Rd 75-3. 1:45pm-particulates from passing vehicles on gravel road. 1:46pm-Downwind of AEC West plant
Site #16		3:22 p.m. to 4:27 p.m.	-2	68	3	W	400m	20%	On Rge Rd 90, 1/4 mi. downwind of Petro Can. Valhalla
Site #13		4:48 p.m. to 5:54 p.m.	-2	69	9	ESE	800m	5%	At wellsite on Rge Rd 94, 1/2 mi. N of Valhalla Enermark plant
Site #14		6:04 p.m. to 7:07 p.m.	-3	76	2	SE	upwind of plant	0%	Stop along Twp Rd 754 near entrance to plant at Rge Rd 9-3
Site # 1	12-Dec	8:58 a.m. to 9:56 a.m.	-10	91	3	W	300m	95%	On Rge Rd 114, 1/2 mi. S of Twp Rd 70-2 9:01am-particulates from gravel road
Site # 3		10:38 a.m. to 11:56 a.m.	-4	83	2	SW	800m	100%	Rge Rd 120 S of #671, 1/2 mi.downwind of Crestar
Site # 4		12:15 p.m. to 1:14 p.m.	-5	83	1	WSW	Lymburn	100%	On Twp Rd 734
Site #10		1:55 p.m. to 2:56 p.m.	0	75	1	SW	Hythe	100%	
Site # 5		3:08 p.m. to 4:09 p.m.	0	80	5	S	Brainard	100%	Twp Rd 74-0 ~Rge Rd 12-1. Heavy Highway traffic toward BC
Site # 6		4:45 p.m. to 5:45 p.m.	-1	81	3	ESE	2km	100%	Stop at well lease Rd 2 mi. E of plant, downwind of AEC Hythe Brainard Plant. Readings from heavy highway traffic.
Site # 2		6:36 p.m. to 7:36 p.m.	2	74	1	SW	Beaverlodge	100%	Beaverlodge Research Station.
Site # 8	13-Dec	8:45 a.m. to 9:50 a.m.	2	93	13	SSW	Martin Lake	ovcst	On Twp Rd 744 1/2 mi W of Rge Rd 113
Site # 9		10:02 a.m. to 11:03 a.m.	2	95	6	WSW	400m	ovcst	On Rge Rd 112, downwind of UPR Knopcik plant
Site #11		11:29 a.m. to 12:29 p.m.	2	92	8	SW	200m	ovcst	Rge Rd 103, downwind of Rigel Knopcik
Site #12		1:00 p.m. to 2:01 p.m.	2	88	10	SW	1500m	ovcst	On Rge Rd 9-2, 1 mi. N of #672
Site #19		2:09 p.m. to 3:22 p.m.	2	85	6	SW	1200m	ovcst	1/4 mi Nof #672 on Rge Rd 8-4
Site #18		3:34 p.m. to 4:35 p.m.	2	83	11	SSW	500m	ovcst	Twp Rd 73-4 & 1/2 mi. W of Rge Rd 8-5. Downwind of Crestar Wembley
Site #17		5:03 p.m. to 6:13 p.m.	-1	85	4	SSW	500-1500m	ovcst	Most of Site17 in transit-travelling round the block.
Site #22	14-Dec	9:15 a.m. to 10:14 a.m.	-5	69	13	W	Teepee Creek	40%	Teepee Creek site on #674
Site #21		10:34 a.m. to 11:39 a.m.	-6	69	22	WSW	800m	20%	On Rge Rd 41, downwind of plant, some odour as we stop
Site #23		12:12 p.m. to 1:15 p.m.	-4	64	12	W	Sexsmith	20%	On edge of town
Site #20		1:45 p.m. to 2:45 p.m.	-3	52	4	SW	1600m	5%	1 mi. downwind (E) of AEC West (particulates from gravel road by passing traffic)
Site #16		3:07 p.m. to 4:07 p.m.	-3	58	14	WSW	800m	5%	1/2 mi. N of Petro Can Valhalla battery. Particulates from traffic on gravel road.
Site #13		4:29 p.m. to 5:35 p.m.	-6	66	9	SSW	600m	10%	On Rge Rd 94, downwind of Valhalla gas plant. Particulates from trucks on gravel road.
Site #15		5:51 p.m. to 6:50 p.m.	-8	74	10	WSW	300m	0%	Near a flare on Rge Rd 9-2 1/2 mi. S of Twp Rd 75-2. Particultes possibly from a nearby flare.
Site #10	15-Dec	8:30 a.m. to 9:38 a.m.	*	*	3	SW	Hythe	20%	Stop on the S side of Hwy 43 at Hythe
Site # 7		10:00 a.m. to 11:01 a.m.	0	71	3	NW	Transboundary	70%	On Rge Rd 133 near BC border
Site # 6		11:22 a.m. to 12:22 p.m.	3	61	12	WNW	500m	40%	On Rge Rd 125 downwind of Hythe Brainard AEC West gas plant. SO_2 & CO readings from gas plant.
Site # 4		12:41 p.m. to 1:41 p.m.	4	58	16	W	Lymburn	20%	On Twp Rd 734
Site # 5		2:00 p.m. to 3:01 p.m.	3	58	23	W	Brainard	10%	Stop at Brainard Lake campsite
Site # 3		3:38 p.m. to 4:53 p.m.	2	63	9	WSW	1500m	10%	Stop on Rge Rd 115.
Site # 2		5:14 p.m. to 6:14 p.m.	-1	74	4	SSW	Beaverlodge	0%	Beaverlodge Research Station.

Table A.15 Weather conditions, monitoring distance from the source and MAML operator's comments (April 8 to 13, 1999).

Monitoring Location	Date	Time (M.S.T.)	Temp.	RH	WSP	WDR	Approximate Distance from the source	Cloud	Operator's Comments
			oC	%	km/h				
Site # 2	8-Apr	7:22 a.m. to 8:27 a.m.	1.8	99	4	NW-WSW	Beaverlodge	100%	At furthest E entrance of 3 entrances into the compound, stop 15m N of Twp Rd. 720.
Site # 3		9:12 a.m. to 10:25 a.m.	0.6	86	15	WNW	200m SW	100%	Rge Rd.120. Plant is 30m from Rge Rd.120.
Site #10		10:55 a.m. to 11:55 a.m.	0.6	88	22	NW	Hythe	100%	250m W of Hwy 43 in Hythe.
Site # 9		12:11 p.m. to 1:23 p.m.	0.8	85	14	NW	109m	100%	Some HC readings directly W of the plant on the road. 2 stacks are flaring. 12:18pm- Note: NO_X is due to compressor activity.
Site # 8		1:29 p.m. to 2:50 p.m.	-1.8	92	17	NW	1.4 km	100%	Rge Rd. 113, 10m N of Hwy 59.
Site # 6		3:11 p.m. to 4:12 p.m.	-1.9	91	17	WNW	1.3 km	100%	200m S of road entrance to gas plant on Rge Rd. 125. No flaring.
Site # 4		4:28 p.m. to 5:31 p.m.	-1.9	94	10	W	Lymburn	100%	On Twp Rd. 734, 50m N of train tracks at the Y in the road.
Site # 5		5:47 p.m. to 6:45 p.m.	-2.1	92	4	WSW-ESE	Brainard	100%	On Rge Rd. 122, 3/4 mi. S of Hwy 43.
Site #24	9-Apr	7:55 a.m. to 8:55 a.m.	-0.8	70	4	SW	186m E	80%	On road going into site.
Site #22		9:11 a.m. to 10:10 a.m.	-1.5	73	10	SW	5.6 km	30%	School parking lot in Teepee Creek.
Site #21		10:21 a.m. to 11:21 a.m.	-0.6	69	12	WSW	500m NE	5%	10:25am-Picked up short burst of SO_2 and H_2S. Wind not strong enough to get more.
Site #23		11:58 a.m. to 12:58 p.m.	1.9	66	6	SW	Sexsmith	5%	95 ave and elevator road in Sexsmith right at the corner. LSD SE-25-73-6W6
Site #25		1:15 p.m. to 2:14 p.m.	2.7	60	6	ESE-WSW	1.2 km	20%	1.5 km N of Hwy 59 on Rge Rd. 65. This is N & E of Site #25.
Site #20		2:39 p.m. to 3:40 p.m.	3.3	49	4	WSW	1.4 km	50%	1.5 km N of north entrance to plant.
Site #17		4:05 p.m. to 5:07 p.m.	2.0	61	13	WNW	1.1 km	50%	Hwy 59 250m W of Rge Rd. 85.
Site #11		5:53 p.m. to 6:54 p.m.	1.1	62	5	E	130m	50%	At entrance to site. Stack is directly W.
Site #19	10-Apr	8:08 a.m. to 9:08 a.m.	-0.2	60	2	NE-WSW	135m NW	50%	135m NW of nearest stack at CCS La Glace on Rge Rd. 85. 8:24am-moved 120 S on Rge Rd. 85, stopped directly W of CCS stacks. 8:27am-odour around area.
Site #12		9:24 a.m. to 10:26 a.m.	-0.1	59	18	WSW	3/4 mi.east	50%	Rge Rd. 92 1 km N of Hwy 672.
Site #18		10:53 a.m. to 11:53 a.m.	5.2	42	2	NE-SW	450m NW	30%	Face W at corner of Rge Rd. 85 & entrance to plant.
Site #16		12:52 p.m. to 1:52 p.m.	4.5	51	8	SSE	1.6 km	60%	Corner of Rge Rd. 91 & Twp Rd. 752.
Site #26		1:59 p.m. to 3:00 p.m.	6.4	35	17	WNW	40m	50%	80m W of Rge Rd. 91 on Twp Rd. 752 for 1 hr.
Site #14		3:33 p.m. to 4:35 p.m.	6.1	36	7	W	100m	70%	At the end of road inside the gate where there is a turnaround area.
Site #13		4:45 p.m. to 5:48 p.m.	4.8	40	22	WSW	250m NE	75%	Stop 250m N of Twp Rd. 754 on Rge Rd. 95.
Site # 3	11-Apr	7:47 a.m. to 8:51 a.m.	4.4	44	4	S	172m NW	50%	Stop 86m N of Goodfare Crestar Energy gas plant and Batt. Stn.
Site #10		9:13 a.m. to 10:15 a.m.	3.6	55	5	ESE	Hythe	100%	180m W of Hwy 43 and directly W of TAGS/Husky store (213m).
Site # 8		10:43 a.m. to 11:44 a.m.	5.9	41	3	S	4.3 km	100%	Corner of Rge Rd. 113 & Twp Rd. 744 . Face W.
Site # 7		12:10 p.m. to 1:12 p.m.	7.1	36	8	SW	1.6 km	100%	2.5 km N of Hwy 43 on road to Gundy.
Site # 6		1:32 p.m. to 2:32 p.m.	6.9	39	8	ESE	360m NE	100%	1/2 mi. W of Rge Rd. 125.
Site # 4		2:49 p.m. to 3:50 p.m.	8.0	37	6	ESE	Lymburn	100%	Twp Rd. 734, 44m S of tracks at bend in the road.
Site # 5		4:01 p.m. to 5:01 p.m.	7.6	37	9	SE	Brainard	100%	Rge Rd. 122, 200m before Twp Rd. 741.
Site # 2		5:32 p.m. to 6:32 p.m.	8.5	36	3	SE	Beaverlodge	90%	E open area beside the Beaverlodge Research Stn.
Site #24	12-Apr	8:24 a.m. to 9:28 a.m.	7.5	59	8	W	10m	40%	10m from Talisman well site.
Site #21		9:50 a.m. to 10:50 a.m.	7.3	63	13	SW	400m NE	10%	400m from source.
Site #25		11:23 a.m. to 12:27 p.m.	6.7	55	24	WSW	800 m	20%	800m Nof Hwy 59 on Rge Rd. 65.
Site #18		1:05 p.m. to 2:16 p.m.	8.4	38	21	W	1.2 km	20%	30m E of Rge Rd. 85 on Twp Rd. 734.
Site #19		2:24 p.m. to 3:23 p.m.	7.3	43	26	WSW	100m	20%	Rge Rd. 85 600m S of Hwy 672. 2:26pm-some THC measured. (Carbotrap on site.)
Site #12		3:36 p.m. to 4:36 p.m.	6.0	38	30	WSW	1.2 km	20%	500m N of Hwy 672 on Rge Rd. 92.
Site #11		4:52 p.m. to 6:18 p.m.	5.5	47	22	W	150m NE	10%	Rge Rd 103 directly W of plant at entrance. Stack flaring. 4:57pm-pick up THC. Carbotrap set out at 5:11pm
Site # 9	13-Apr	7:50 a.m. to 8:51 a.m.	0.8	44	24	W	157m W	0%	Rge Rd. 112 directly E of plant. 7:53 pm-Note: picked up 6.9 ppm of THC.
Site #13		9:35 a.m. to 10:35 a.m.	1.5	40	36	W	310m east	5%	W of Site13 on Rge Rd 95. 750m N of Twp Rd 754. (9:41am-slightly elevated THC)
Site #13		10:42 a.m. to 11:43 a.m.	1.9	41	30	WNW	277m east	5%	N on Rge Rd. 94, 95m N of Twp Rd. 754.
Site #15		12:01 p.m. to 12:25 p.m.	5.0	29	12	SE	10m	5%	10m downwind from pump jack.
Site # 6a		1:13 p.m. to 1:43 p.m.	4.8	29	5	W	2.0 km	10%	1.5 mi. E of Site #6.
Site # 6		1:58 p.m. to 3:02 p.m.	4.2	31	26	W	800m	10%	400m S of Site6 entrance. 2:13pm-19 ppb SO_2, 2:26pm-20 ppb SO_2
Site #17		3:38 p.m. to 4:38 p.m.	4.6	41	27	WNW	800m	50%	1/2 mi. N of Hwy 59 on Rge Rd. 85.
Site #20		4:57 p.m. to 6:34 p.m.	5.3	32	13	W	197m	10%	107m N of north gate entrance. Very small flame on stack. Reading slight THC and some SO_2. (5:04pm-30 ppb SO_2).

Table A.16 Weather conditions, monitoring distance from the source and MAML operator's comments (April 16 to 21, 1999).

Monitoring Location	Date	Time (M.S.T.)	Temp.	RH	WSP	WDR	Approximate Distance from the source	Cloud	Operator's Comments
			oC	%	km/h				
Site #13	16-Apr	8:38 a.m. to 9:42 a.m.	6	58	3	SSE	800m	80%	Rge Rd 95 1 km N of Twp Rd 754.
Site #14		10:28 a.m. to 11:29 a.m.	14	31	8	SW	400m	60%	Wellsite 9-27-75-9 W6.
Site #16		11:52 a.m. to 12:54 p.m.	15	34	7	SSW	300m	60%	Rge Rd. 90, 1.2 km S of Twp Rd 752.
Site #20		1:25 p.m. to 2:29 p.m.	18	25	10	WSW	1.5km	40%	Stop along bend in #724 at a point 2km N of Twp Rd 750.
Site #25		3:02 p.m. to 4:00 p.m.	19	29	17	WSW	500m	10%	1.5km Nof Hwy 59 on Rge Rd 65.
Site #21		4:33 p.m. to 5:33 p.m.	20	28	7	WSW	800m	10%	Rge Rd 41 350m N of Hwy 59.
Site #24		5:55 p.m. to 6:54 p.m.	18	28	7	WNW	1km	10%	Wellsite 400m W of #733. LSD 8-21-72-3.
Site # 8	17-Apr	8:59 a.m. to 9:59 a.m.	11	40	10	ENE	Martin Lake	70%	Twp Rd. 744, 800m W of Rge Rd 113.
Site # 9		10:16 a.m. to 11:17 a.m.	14	38	6	S	800m	40%	Stop at corner of Hwy 59 & Rge Rd. 112.
Site #10		11:38 a.m. to 12:45 p.m.	15	34	6	S	Hythe	0%	On edge of town, near sewage lagoons. (11:55am-NH_3 from small feedlot to the SW).
Site #11		1:01 p.m. to 2:02 p.m.	15	34	8	SE	250m	0%	Rge Rd. 103 & Twp Rd. 734.
Site #17		2:24 p.m. to 3:25 p.m.	17	34	6	SSW	500m	0%	1/2 km W of Rge Rd. 85 & 2 km N of Hwy 59.
Site #18		3:46 p.m. to 4:50 p.m.	17	37	9	SE	1km	10%	Rge Rd. 90 & Twp Rd. 734, 1 km NW of plant.
Site #19		5:17 p.m. to 6:19 p.m.	17	35	9	SE	100m	0%	Rge Rd. 85 near plant entrances. 5:32pm-occasional mercaptan/hc smells from CCS La Glace facility. Particulates from gravel road dust.
Site #12	18-Apr	7:55 a.m. to 9:07 a.m.	8	66	1	NNE-SSE	1.5km	99%	Wellsite road on Rge Rd. 92 1km Nof Hwy 672.
Site # 1		10:15 a.m. to 11:21 a.m.	11	60	2	W	800m	100%	Rge Rd. 114, 1.5km S of #667. CO from compressor.
Site # 3		12:23 p.m. to 1:32 p.m.	15	42	12	W	Plant out of service	100%	Rge Rd. 121, 1km N of Twp Rd. 722.
Site # 4		1:54 p.m. to 2:54 p.m.	13	52	13	SW	Lymburn	100%	Twp Rd. 734, 1km W of Rge Rd. 123.
Site # 6		3:16 p.m. to 4:18 p.m.	15	42	12	SW	800m	100%	Plant access road on Rge Rd. 125 1.5 km S of Hwy 43. Particulates & NO_X from passing trucks.
Site # 5		4:36 p.m. to 5:41 p.m.	14	42	13	SW	Brainard	99%	At well site road (Rge Rd. 122 curves 1 mi. S of Hwy 43)
Site # 2		6:12 p.m. to 7:12 p.m.	14	41	4	WSW	Beaverlodge	no data	Beaverlodge Research Station.
Site #13	19-Apr	8:42 a.m. to 9:40 a.m.	10	49	12	W	800m	0%	200m N of Twp Rd. 754.
Site #14		9:48 a.m. to 10:48 a.m.	12	55	11	WNW	800m	0%	Wellsite road 380m N of Twp Rd. 754. ~800m ENE of AEC Valhalla Battery.
Site #26**		11:06 a.m. to 12:22 p.m.	12	54	13	WNW	150m	60%	100m S of Twp Rd. 752 on Rge Rd. 9. Heavy petroleum odour, high RHC readings. Trucks loading/unloading. Readings don't seem related to truck activities. CO from compressors on site.
Site #16		12:34 p.m. to 1:35 p.m.	11	65	18	NW	500m	80%	Rge Rd. 90, 1 mi. N of Twp Rd. 750.
Site #20		2:14 p.m. to 3:14 p.m.	12	60	13	NNW-S	800m	60%	Stop at Y in road 3/4 mi N of Twp Rd. 750. Downwind of AEC Saddle Hills Gas Plant.
Site #17		4:47 p.m. to 5:49 p.m.	12	63	17	NNE	1km	60%	Stop along Hwy 59. At wellsite 1/4 mi Eof Rge Rd. 90, ~ 1 km SSW of battery flare.
Site # 8	20-Apr	7:58 a.m. to 9:02 a.m.	8	53	5	ENE-NNE	Martin Lake	80%	1/2 mi Wof Rge Rd. 113 on Twp Rd. 744.
Site # 5		9:17 a.m. to 10:17 a.m.	10	45	4	NE-WNW	Brainard	70%	Access road 1 mi S of Hwy 43 on Rge Rd. 122.
Site #10		10:33 a.m. to 11:35 a.m.	13	37	8	ENE-ESE	Hythe	80%	Stop at location 200 m from Hwy 43.
Site #12		12:06 p.m. to 1:07 p.m.	14	35	11	E	400m	40%	150m N of #672 on Rge Rd. 93.
Site #19		1:25 p.m. to 2:29 p.m.	15	32	9	NE	100m	40%	Rge Rd. 85 at gate to CCS La Glace Facility. 40m to tanks on lot. Particulates from truck activities. Petroleum odours from activities at CCS. Manager said they were loading trucks from an open pit.
Site #18		2:36 p.m. to 3:39 p.m.	15	31	12	NNE-SSW	2.5km	60%	Rge Rd. 91 1/4 mi N of Hwy 672 on wellsite road approach.
Site # 3		4:12 p.m. to 5:22 p.m.	14	33	9	SSE-NNE	200m	70%	At plant gates to Crestar Goodfare gas plant. NO/NO_2 likely from compressor stacks on plant site.
Site # 2		5:43 p.m. to 7:06 p.m.	11	69	12	SE-ESE	Beaverlodge	70%	Beaverlodge Research Station.
Site # 4	21-Apr	8:47 a.m. to 9:50 a.m.	10	72	10	E	Lymburn	10%	Lymburn on Twp Rd. 734.
Site # 6		10:13 a.m. to 11:27 a.m.	12	50	6	SE	2.5km	60%	Landfill entrance on Rge Rd. 131, 2 mi S of Hwy 43.
Site # 9		12:00 p.m. to 1:03 p.m.	12	36	15	SE	800m	30%	Along Hwy 59 downwind of UPR Knopcik. 1/2 mi Wof Rge Rd. 112 on Hwy 59.
Site #11		1:17 p.m. to 2:21 p.m.	13	34	12	ESE	200m	40%	Twp Rd. 734, 200m W of Rge Rd. 103. Approx 180m SSW of Rigel Knopcik flarestack.
Site #26		3:09 p.m. to 4:12 p.m.	12	33	6	NW	800m	60%	Wellsite 14-11-75-9. Downwind of Crestar Valhalla Oil Battery/Waterflood.

Table A.17 Weather conditions, monitoring distance from the source and MAML operator's comments (June 15 to 20, 1999).

Monitoring Location	Date	Time (M.S.T.)	Temp.	RH	WSP	WDR	Approximate Distance from the source	Cloud	Operator's Comments
			oC	%	km/h				
Site # 8	15-Jun	8:25 a.m. to 9:28 a.m.	20	55	10	SE-SW	Martin Lake	0%	Twp Rd 744, 800m W of Rge Rd 113.
Site # 9		9:44 a.m. to 10:45 a.m.	23	46	13	E	1km	0%	Rge Rd 113 1km S of Hwy 59. Particulates but no apparent road or field dust.
Site #10		10:56 a.m. to 11:56 a.m.	24	42	18	E	Hythe	0%	Hythe campground at 100 ave & 104 st. Tractor is mowing the grass.
Site #11		12:23 p.m. to 1:23 p.m.	26	35	18	E-SE	200m	0%	200m W of Twp Rd. 734 & Rge Rd. 1033. Travel through paving operation odours.
Site #12		1:46 p.m. to 2:47 p.m.	26	35	20	E-SE	400m	0%	Rge Rd 93, 1/2 mi. N of Hwy 672.
Site #19		2:57 p.m. to 3:57 p.m.	27	29	19	E-SE	100m	0%	Downwind of CCS La Glace. In driveway of Peace Pipe, loading terminal across the street. Trucks entering both yards causing dust. Strong odours from CCS La Glace.
Site #17		4:42 p.m. to 5:41 p.m.	27	26	30	E	800m	0%	Rge Rd 90, 800m N of Hwy 59.
Site #18		6:32 p.m. to 7:37 p.m.	26	28	24	E	400m	0%	Lease rd. to Crestar Wembley Battery (~ Twp Rd. 733A & Rge Rd. 85A). Odours.
Site #13	16-Jun	7:42 a.m. to 8:49 a.m.	20	51	9	E	500m	0%	Corner of Rge Rd 95 & Twp Rd 754.
Site #14		9:07 a.m. to 10:16 a.m.	22	46	7	SE	800m	0%	100 m N of Twp Rd 754 on wellsite rd = Rge Rd 93
Site #16		10:49 a.m. to 11:50 a.m.	23	44	12	SE	1 mile	0%	Well site road 1km S of Twp Rd. 752 on Rge Rd 91.
Site #25		12:43 p.m. to 2:05 p.m.	26	38	6	SE-SW	1km	0%	1km N of Hwy 59 on Rge Rd 70.
Site #21		2:38 p.m. to 3:48 p.m.	26	40	10	SW	800m	50%	1 km N of Hwy 674 on Rge Rd 41.
Site #22		3:54 p.m. to 4:57 p.m.	25	45	17	SW	Teepee Creek	80%	Teepee Creek school.
Site #20		5:45 p.m. to 6:46 p.m.	23	46	3	SW	1500m	90%	At approach road along Hwy 724 near county boundary.
Site # 1	17-Jun	7:43 a.m. to 8:48 a.m.	23	43	6	NW	200m	0%	Elmworth plant gates, set out carbotraps.
Site # 3		9:42 a.m. to 10:43 a.m.	23	38	7	SW	1km	20%	1km S of Hwy 671 on Rge Rd 115.
Site # 4		11:10 a.m. to 12:17 p.m.	26	29	5	NW-SW	Lymburn	20%	Twp Rd 734.
Site # 6		1:04 p.m. to 2:23 p.m.	25	30	4	NW	1km	40%	0.5 km from Rge Rd 125, 1km SE of plant.
Site # 7		2:50 p.m. to 3:48 p.m.	26	28	4	SW	Transboundary	60%	Gundy Rd. 2km N of Hwy 43.
Site # 5		4:20 p.m. to 5:50 p.m.	27	29	4	E	Brainard	20%	Brainard.
Site # 2		6:18 p.m. to 7:19 p.m.	25	31	7	SE	Beaverlodge	10%	Beaverlodge Research Station.
Site # 8	18-Jun	8:13 a.m. to 9:30 a.m.	21	51	4	S	Martin Lake	0%	1/2 mi. W of Rge Rd 113 on Twp Rd 744.
Site # 9		9:38 a.m. to 10:48 a.m.	24	45	9	E	800m	10%	1km E of Rge Rd 112 on Hwy 59.
Site #10		10:58 a.m. to 12:10 p.m.	25	40	10	E	Hythe	10%	Hythe Campground.
Site # 9		12:25 p.m. to 1:25 p.m.	26	42	13	SE	400m	20%	Twp Rd 734, 1/2 km W of Rge Rd 112.
Site #12		2:18 p.m. to 3:20 p.m.	16	77	27	W	500m	Ovcst	1/2 mi. N of Hwy 672 on Rge Rd 93.
Site #18		3:31 p.m. to 4:41 p.m.	14	96	5	W	2km	Ovcst	Rge Rd 85, S of Twp Rd 732.
Site #19		5:18 p.m. to 6:18 p.m.	16	80	8	N-NW	400m	Ovcst	At approach road on Rge Rd 85, just S of Peace Pipe. Downwind .
Site #13	19-Jun	7:55 a.m. to 8:53 a.m.	13	75	13	SW	500m	Ovcst	Rge Rd 94, 500m N of Twp Rd 754. Downwind of Crestar Valhalla.
Site #14		9:22 a.m. to 10:21 a.m.	15	59	19	W-SW	1 km	Ovcst	Wellsite 1-27-75-9. (1km E of AEC West Valhalla Oil Battery).
Site #26		10:35 a.m. to 11:42 a.m.	16	53	20	W	500m	Ovcst	Wellsite road ~500m directly E of Site #26.
Site #16		11:49 a.m. to 1:01 p.m.	19	41	18	W	300m	Ovcst	Stop alongside Petrocan Valhalla.
Site #20		1:36 p.m. to 2:37 p.m.	19	31	17	SW	1km	80%	At approach along Hwy 724 (~1km downwind of stack).
Site #21		3:26 p.m. to 4:46 p.m.	21	33	30	W	500m	60%	Rge Rd 41, 1/4 mi. N of Hwy 674 (Sulphur odour). 4:03pm-CO readings from plant.
Site #24		5:05 p.m. to 6:06 p.m.	20	29	33	SW	800m	40%	Hwy 723 ~300m S of Twp Rd 724. Downwind of Talisman Manir Battery 14-21-72-3.
Site # 3	20-Jun	7:37 a.m. to 8:37 a.m.	12	69	5	SW	100m	Ovcst	NE corner of plant site. NO/NO_x from plant.
Site # 1		9:21 a.m. to 10:38 a.m.	17	51	4	SE-NW	300m	Ovcst	At access road 1km S of Hwy 667 on Rge Rd 114.
Site # 4		11:39 a.m. to 12:38 p.m.	17	46	13	S	Lymburn	90%	Rge Rd 734.
Site # 5		12:51 p.m. to 1:55 p.m.	18	43	10	SW	Brainard	80%	2km S of Hwy 43.
Site # 6		2:20 p.m. to 3:22 p.m.	17	42	13	SW	400m	80%	Rge Rd 125, E of stack ~250m S of plant access rd.
Site #2		4:27 p.m. to 5:27 p.m.	19	38	12	SW	Beaverlodge	70%	Beaverlodge Research Station.

Table A.18 Weather conditions, monitoring distance from the source and MAML operator's comments (June 23 to 28, 1999).

Monitoring Location	Date	Time (M.S.T.)	Temp.	RH	WSP	WDR	Approximate Distance from the source	Cloud	Operator's Comments
			oC	%	km/h				
Site #24	23-Jun	9:03 a.m. to 10:05 a.m.	9	88	14	W-NW	500m	100%	Turn S onto Hwy 733. Turn W onto Twp Rd 724.
Site #21		10:28 a.m. to 11:28 a.m.	10	85	15	W	500m	100%	Directly E of Site # 21 on Rge Rd 41.
Site #23		11:48 a.m. to 1:03 p.m.	9	86	20	NW	Sexsmith	100%	At corner of 100 ave. & 100 st. in Sexsmith.
Site #25		1:18 p.m. to 2:19 p.m.	11	79	19	W	500m	100%	Directly E of Site #25 on Rge Rd 65.
Site #18		2:48 p.m. to 4:06 p.m.	13	66	20	N	400m	100%	At Site #18 on Twp Rd 733 550m E of Rge Rd 85.
Site #19		4:17 p.m. to 5:17 p.m.	14	58	20	W	150m	100%	Downwind of Site#19 Peace Pipe-S.E. corner of site (350m to nearest storage tank).
Site #12		5:27 p.m. to 6:28 p.m.	14	60	15	W-NW	300m	95%	500m E of Site #12 entrance on Hwy 672.
Site #13	24-Jun	7:51 a.m. to 8:52 a.m.	13	59	7	E	2.5 km	90%	Twp Rd 752 & Rge Rd 10-0. Nearest source-Site #19 &20 (or #14 from that wind direction).
Site #13		9:12 a.m. to 10:20 a.m.	14	54	4	E-SW	600 m NE	85%	Entrance to Crestar Energy Valhalla source well. Between Rge Rd. 95 & 10-0.
Site #14		10:51 a.m. to 12:01 p.m.	15	43	6	E-SE	1.6 km	85%	Entrance to AEC oil & gas. 1 mi. W of Site14-top of hill on Twp Rd 754-Site14 shut down-compressor motor failure. Flaring.
Site #13		12:09 p.m. to 1:15 p.m.	14	48	11	NE-SW	400m	90%	Stop adjacent to meter stn. Site#13 and face E. No rain.
Site #15		1:30 p.m. to 2:31 p.m.	15	43	7	NW-SE	10 m	100%	Site #15 about 10m from pump.
Site #26**		2:48 p.m. to 3:48 p.m.	14	48	9	NW-SE	80m	100%	Stop 60m W of Site26 on Twp Rd 752. (2:52pm-THC, RHC, off scale)
Site #20		4:26 p.m. to 5:33 p.m.	16	45	9	NW-SE	1.6 km	90%	SW of Site20 on Twp Rd 750 & 1/2 mi. W of Hwy. 724. Road is dusty.
Site #17		5:51 p.m. to 6:54 p.m.	14	49	13	E	800m	90%	1/2 mi. W of Site #17 on Rge Rd 85.
Site # 3	25-Jun	8:05 a.m. to 9:06 a.m.	10	74	6	E	30m	85%	No comments.
Site # 4		9:27 a.m. to 10:40 a.m.	12	70	7	E-SE	Lymburn	100%	N side of tracks at Site #4.
Site # 5		10:52 a.m. to 11:54 a.m.	12	65	4	SW	Brainard	100%	Entrance road to Brainard Lake on Rge Rd 122 & 700m S of Hwy 2.
Site # 6		12:07 p.m. to 1:09 p.m.	13	58	6	E	100m	100%	At end of east/west road leading into plant.
Site # 9		1:33 p.m. to 2:37 p.m.	14	51	7	SE	30m	100%	1:50 pm-after turning 1of 2 stacks off, RHC picked up for short time. Stack that was shut off re-lit using flare gun.
Site #10		2:50 p.m. to 3:51 p.m.	15	50	5	E	Hythe	100%	In Hythe - W side of the hwy. Dust from vehicles.
Site #11		4:10 p.m. to 5:12 p.m.	15	54	4	SE	800m	100%	Stop 700m W of Rge Rd 10-3 on Twp Rd 734 downwind of site. No rain.
Site # 2		5:34 p.m. to 6:31 p.m.	15	53	4	SE-SW	Beaverlodge	85%	Stop beside shop where MAML is housed.
Site #24	26-Jun	7:55 a.m. to 9:00 a.m.	14	68	5	E-SW	600m	sunny	At N Site #24 on Twp Rd 724 between Hwy 733 & Rge Rd 34.
Site #21		9:34 a.m. to 10:38 a.m.	17	53	8	E-SE	1.3 km	10%	Site#21on Rge Rd 42 NE (downwind of stack &900m N of Hwy 674.)
Site #25		11:15 a.m. to 12:16 p.m.	18	46	7	S-SE	800m	80%	On Rge Rd 65 800m N of Hwy 59 (E of Site#25).
Site #17		1:23 p.m. to 2:14 p.m.	21	33	10	N	800m	80%	Talk to area resident - reports no odour problems.
Site #20		2:41 p.m. to 3:41 p.m.	20	35	6	S	2.6 km	70%	2.5 km. Nof Site#20 to get downwind of stack.
Site #18		4:11 p.m. to 5:03 p.m.	18	47	11	W	600m	95%	550m W of Rge Rd 85. Grass fire-Hwy 672 & Rge Rd 80.
Site #19		5:41 p.m. to 6:46 p.m.	16	47	10	SW-NW	100m	95%	N on Rge Rd 85 downwind of Site #19, Peace Pipeline on SE corner of facility. 2 trucks at pump stn. Flaring when we arrived.
Site #13	27-Jun	7:37 a.m. to 8:38 a.m.	13	56	22	SW-W	800m	sunny	NE of Site #13A downwind & 600m Nof entrance to site.
Site #13		8:47 a.m. to 9:47 a.m.	14	48	22	SW	350m	sunny	22m N of Twp Rd. 754 on Rge Rd. 94.
Site #14		10:13 a.m. to 11:15 a.m.	17	38	13	SW-W	1 km	sunny	300m N of Twp Rd 754 on Rge Rd 92 ~ 1 km from stacks.
Site #26		11:27 a.m. to 12:27 p.m.	18	32	17	SW-W	60m	sunny	Twp Rd 752 & Rge Rd 91. No trucks unloading. (11:46am-move to S side of road.)
Site #16		12:35 p.m. to 1:35 p.m.	18	29	20	SW-W	30m	sunny	Adjacent to Site #16 on Rge Rd 90.
Site #20		1:59 p.m. to 3:20 p.m.	18	28	20	S-SW	1 km	sunny	900m N of gate into Site#20.
Site #18		4:42 p.m. to 5:53 p.m.	22	24	5	W-SW	1.6 km	sunny	E of Site #18 on Rge Rd 85.
Site # 4	28-Jun	7:46 a.m. to 8:48 a.m.	14	47	11	SW-W	Lymburn	sunny	Site#4 N&E of tracks ~ 100m (Twp Rd 734).
Site # 6		9:09 a.m. to 10:10 a.m.	16	40	9	SW-W	900m	sunny	200m N of entrance to Site#6 on Rge Rd 125.
Site # 5		10:20 a.m. to 11:20 a.m.	17	43	9	W	Brainard	sunny	At Site#5 700m S of Hwy 2.
Site # 9		11:39 a.m. to 12:39 p.m.	17	37	14	SW-W	200m	sunny	Adjacent to Site#9 on Rge Rd 112.
Site #10		1:03 p.m. to 2:04 p.m.	18	36	19	W	Hythe	sunny	W of Hwy 2 in Hythe (1:05pm-Particulates, there is a tractor in the field W of MAML cutting grass.)
Site #11		2:22 p.m. to 3:24 p.m.	19	31	23	W	250m	sunny	Adjacent to Site #11 on Rge Rd 10-3.
Site # 2		3:47 p.m. to 4:47 p.m.	19	32	12	S-SW	Beaverlodge	sunny	Turn into Beaverlodge Research Station & cont. N to top of hill. (3:49 pm-Increased particulates from wood burning just W of the agr-stn.)

Table A.19 Weather conditions, monitoring distance from the source and MAML operator's comments (October 14 to 19, 1999).

Monitoring Location	Date	Time (M.S.T.)	Temp.	RH	WSP	WDR	Approximate Distance from the source	Cloud	Operator's Comments
			oC	%	km/h				
Site # 1	14-Oct	8:19 a.m. to 9:19 a.m.	5	52	30	W	400m	10%	Along Rge Rd 114.
Site #23		10:59 a.m. to 12:03 p.m.	7	42	38	SE	Sexsmith	40%	Readings from other vehicles.
Site #27		12:11 p.m. to 1:14 p.m.	8	38	36	W	300m E	60%	Well testing "frac test" going on, (12:12pm-large flare, stopped 300m E of it).
Site #28		1:31 p.m. to 3:01 p.m.	8	38	37	W	600 m	60%	Twp Rd 730 & Rge Rd 60, N of Clairmont. Well is under test. 1:58pm-downwind of flare.
Site #24		3:33 p.m. to 4:33 p.m.	9	36	22	W	800m	70%	Along Hwy 733, 1200m N of Hwy 43.
Site #21		4:56 p.m. to 6:11 p.m.	7	39	29	W	500m	50%	Rge Rd 41, 1/4 mi. N on Hwy 674.
Site # 3	15-Oct	8:21 a.m. to 9:23 a.m.	1	63	12	W	150m	40%	Small road along N side of plant. 8:23am-slight odours at MAML. 8:24am-Strong odours 70m away at carbotrap site.
Site # 5		9:44 a.m. to 10:44 a.m.	6	48	6	NW	Brainard	20%	Brainard Lake camping area.
Site # 6		10:57 a.m. to 12:02 p.m.	6	48	12	NW-SW	800m	no data	Access road just S of AEC plant road, SE of stacks.
Site #10		12:27 p.m. to 1:28 p.m.	7	43	16	NW	Hythe	20%	Hythe campground.
Site # 8		1:44 p.m. to 2:44 p.m.	7	39	10	W	Martin Lake	20%	Twp Rd 744. 1/2 mi. W of Rge Rd 113.
Site # 9		2:58 p.m. to 3:59 p.m.	7	36	10	W-NW	200m	10%	Plant gates. NO_X and CO readings from plant, likely compressor stacks.Propane type odours evident. 3:46pm-Lge flare on stack. 3:47pm-set out carbo traps.
Site #11		4:19 p.m. to 5:23 p.m.	7	36	6	S	150m	10%	At plant gates.
Site # 2		6:21 p.m. to 7:20 p.m.	3	49	12	SW	Beaverlodge	0%	Beaverlodge Research Station.
Site #13	16-Oct	8:39 a.m. to 9:40 a.m.	3	60	17	S-SE	500m	Ovcst	1/2 mi N of Twp Rd 754. 8:41am-faint odours.
Site #26*		10:13 a.m. to 11:46 a.m.	4	70	7	SE	100m	Ovcst	In front of gates 70 m W of Rge Rd 91 on Twp Rd 752. 10:15am-Strong petroleum odour coming from storage tanks. 11:13am-First truck starts to unload. 11:14am-NO/NO_X from idling truck unloading.
Site #26**		11:57 a.m. to 12:21 p.m.	5	74	7	SE	100m	Ovcst	11:47am-wind shifted slightly, no longer in strongest plume. 11:55am-move ahead a few meters to get into plume again.
Site #16		12:30 p.m. to 1:37 p.m.	8	61	18	SW	300m	90%	Rge Rd 90, 1/4 mi. N of Petrocan plant. 1:19 pm-sour hydrocarbon odour, could be from trucks unloading.
Site #20		2:03 p.m. to 3:07 p.m.	8	60	17	SW	800m	Ovcst	On road just SE of AEC plant.
Site #18		4:34 p.m. to 5:36 p.m.	11	54	19	W	1km	90%	Rge Rd 85A, 1/2 mi. N of Twp Rd 733.
Site #19		5:45 p.m. to 6:44 p.m.	9	59	23	W	250m	90%	In front of and downwind of Peace Pipe La Glace station. 5:46pm-some odours.
Site#12	17-Oct	8:12 a.m. to 9:12 a.m.	8	58	13	SW	800m	0%	Wellsite road 1/2 mi. NE of plant.
Site #17		9:43 a.m. to 10:45 a.m.	12	45	21	W-SW	800m	0%	1/2 mi. N of Hwy 59 on Rge Rd 85.
Site #27		11:24 a.m. to 12:24 p.m.	12	41	21	W	150m	20%	Rge Rd 61, alongside well test. 11:26am-Deisel type odour from recovered oil. 11:28am-Well test underway, 'frac test' pumping out oil injected into hole before production gas is allowed to flow. 11:37am-Set out carbo traps.
Site #23		12:46 p.m. to 1:46 p.m.	13	39	18	W	Sexsmith	80%	Sexsmith
Site #28		2:03 p.m. to 3:07 p.m.	14	35	19	W-SW	100m	70%	Stop adjacent to well site. 2:02pm.Petroleum odours from temporary storage tanks left on site after well test. 2:04pm-Well test has been finished, temporary flare is dismantled.
Site #21		3:30 p.m. to 4:32 p.m.	14	36	7	W	500m	90%	3:31pm-Sulpherous odour evident with occasional H_2S.
Site #22		4:38 p.m. to 5:38 p.m.	12	40	9	W-NW	5km	90%	Teepee Creek School. 4:40pm-SO_2 readings from Talisman plant 3 mi. away.
Site # 1	18-Oct	8:24 a.m. to 9:25 a.m.	2	81	3	SW	800m	80%	SO_2 readings from Talisman plant 3 mi. away , no lower level wind but upper level wind is from the plant (SW) 8:25am-NO, NO_2 likely from compressors on site.
Site # 3		10:14 a.m. to 11:17 a.m.	11	45	17	SW	100m	20%	S side of plant compound. 10:16am-Odours detected from 2 different plant sources.
Site # 6		11:58 a.m. to 12:57 p.m.	13	37	18	SW	500m	40%	Plant access road at Rge Rd 125.
Site # 9		1:14 p.m. to 2:13 p.m.	14	33	17	W	200m	40%	1:15pm-Propane type odours, possibly from large tanks.
Site #11		2:34 p.m. to 3:36 p.m.	16	29	19	W	150m	20%	2:39pm-move ahead a bit, slight odours from plant.
Site #10		3:47 p.m. to 4:47 p.m.	16	31	23	W	Hythe	20%	Hythe campground.
Site # 4		5:05 p.m. to 6:04 p.m.	14	39	15	SW	Lymburn	10%	Lymburn.
Site # 2		6:51 p.m. to 7:50 p.m.	9	53	5	S-SW	Beaverlodge	10%	Beaverlodge Research Station.
Site #20	19-Oct	8:31 a.m. to 9:36 a.m.	11	56	10	W-SW	800m	0%	Road ~1/2 mi. from plant on #724. 8:55am-turn around, travel E on # 724. 9:10am-Stop at dump access road.
Site #26		10:05 a.m. to 11:17 a.m.	15	40	27	W	100m	20%	Twp Rd 752 & Rge Rd 91.
Site #16		11:29 a.m. to 12:28 p.m.	16	35	39	W	200m	80%	In front of Petro Can, Site #16.
Site #17		1:00 p.m. to 2:00 p.m.	17	35	35	W-SW	800m	80%	Rge Rd 85, downwind of AEC battery, Site #17.
Site #18		2:48 p.m. to 3:47 p.m.	19	31	14	W	300m	60%	Site #18.
Site #19		3:56 p.m. to 4:58 p.m.	18	32	36	W	250m	20%	Alongside & downwind of Peace Pipe. 3:59pm-odours from truck terminal operations.
Site #12		5:09 p.m. to 6:09 p.m.	15	38	34	W	1km	40%	Rge Rd 92 1/4 mi. N of Hwy 672.

Table A.20 Weather conditions, monitoring distance from the source and MAML operator's comments (October 22 to 27, 1999).

Monitoring Location	Date	Time (M.S.T.)	Temp.	RH	WSP	WDR	Approximate Distance from the source	Cloud	Operator's Comments
			oC	%	km/h				
Site #24	22-Oct	9:25 a.m. to 10:25 a.m.	8	76	7	SE	800m	20%	LSD 8-21-72 3W6 downwind of Site#24. 10:18am-Site#27 & 28 are both capped and no odours are detected. These sites will not be monitored.
Site #21		10:47 a.m. to 11:53 a.m.	13	64	4	SW	500m NW	20%	10:48am-Pick up SO_2. Stop 450m N of Hwy674 on Rge Rd 41.
Site #23		12:15 p.m. to 1:15 p.m.	16	48	7	W	Sexsmith	20%	100 ave. & 100 st. in Sexsmith.
Site #20		2:05 p.m. to 3:05 p.m.	18	29	9	S	2.5 km	20%	Entrance to La Glace landfill - NE of Site #20 ~ 1.7 km.
Site #18		3:58 p.m. to 4:58 p.m.	16	56	7	SE	1.2 km	25%	Twp Rd 734 & Rge Rd 90, N & W of Site#18.
Site #19		5:19 p.m. to 6:21 p.m.	11	75	4	V	40m	no data	No comments.
Site # 3**	23-Oct	8:08 a.m. to 9:09 a.m.	2	87	2	V	25m	0%	8:34am-THC&RHC off scale. 8:37am-Uprange THC&RHC to 50 ppm from 20 ppm.
Site #10		9:39 a.m. to 10:40 a.m.	5	77	4	NE	Hythe	0%	W side of Hwy 43. Hwy is 150m E of MAML.
Site # 6		11:04 a.m. to 12:04 p.m.	12	45	6	SE	360m NW	0%	500m down the construction road which is W of the road going into the plant.
Site # 4		12:20 p.m. to 1:19 p.m.	13	46	10	NE	Lymburn	0%	250m W of Rge Rd 123 on Twp Rd 734.
Site # 5		1:31 p.m. to 2:31 p.m.	16	40	6	E	Brainard	0%	700m S of Hwy. 43, in open field beside Brainard Lake.
Site # 9		2:44 p.m. to 3:44 p.m.	14	46	9	NE	1.4 km	0%	Downwind of Site9(1.2 mi.E of MAML&700m S of Hwy59)
Site #12		4:14 p.m. to 5:14 p.m.	13	52	8	SE	475m NW	0%	500m N of Hwy. 672 on Rge Rd. 93. MAML is 475m NW of Site #12 stack .
Site # 2		5:30 p.m. to 6:30 p.m.	14	38	8	SE	Beaverlodge	0%	30m S of bldg where MAML is parked overnight. Face E.
Site #13	24-Oct	8:06 a.m. to 9:06 a.m.	5	42	38	SW	430m	5%	30m N of entrance to Site#13A.
Site #13		9:18 a.m. to 10:18 a.m.	6	41	42	SW	650m	0%	600 N of Twp Rd 754 on Rge Rd 94.
Site #14		10:33 a.m. to 11:33 a.m.	7	36	28	SW	1.2 km	0%	300m N of Twp Rd. 754. 10:56am-Move off road and into small battery and face W 20m E of original position due to wide load traffic.
Site #26		11:43 a.m. to 12:43 p.m.	7	35	30	W	50m	0%	Turn S onto Rge Rd 91 & stop 20m S of Twp Rd 752.
Site #16		12:52 p.m. to 1:52 p.m.	8	33	32	SW	20m	5%	Adjacent to Site #16, on road. 12:54pm & 1:45pm-Road dust & NO_x from Semi-trailers.
Site #20		2:12 p.m. to 3:12 p.m.	9	30	17	SW	240m	0%	200m N of entrance to Site#20.
Site # 9		3:52 p.m. to 4:52 p.m.	8	36	23	W	80m	0%	Adjacent to Site#9.
Site #11		5:18 p.m. to 6:18 p.m.	6	43	19	W	140m	0%	40m S of entrance to Site#11. 6:02pm-move back 160m.
Site # 1	25-Oct	8:16 a.m. to 9:16 a.m.	0	79	5	V	30m	100%	E side, adjacent to Site#1 on Rge Rd 114.
Site #24		10:41 a.m. to 11:41 a.m.	6	42	11	E	500m E	40%	Directly W of Site#24 on Rge Rd 34.
Site #21		12:03 p.m. to 1:11 p.m.	9	33	12	SE	840m	40%	30m N of Hwy 674 on Rge Rd 42.
Site #23		1:28 p.m. to 2:28 p.m.	8	35	6	SE	Sexsmith	90%	100 ave. & 100 st. in Sexsmith.
Site #25		2:57 p.m. to 3:57 p.m.	9	34	9	E	1.2 km	60%	3/4 mi. N of Hwy 59.
Site #17		4:19 p.m. to 5:19 p.m.	6	47	5	E	1 km NW	60%	1.5 km. N of Hwy 59.
Site #12		5:41 p.m. to 6:42 p.m.	5	57	3	E	1.1 km	60%	550m N of Hwy 672 on Rge Rd 93.
Site # 3	26-Oct	8:11 a.m. to 9:11 a.m.	3	65	23	S-SW	50m	0%	Site#3 on N side. 8:13am-NO_2 and RHC detected from plant.
Site #10		9:47 a.m. to 10:47 a.m.	4	57	26	W	Hythe	0%	Stop on the NW side of Hythe for Site #10.
Site # 6		11:06 a.m. to 12:06 p.m.	5	49	25	W	800m	5%	100m S of entrance to Site 6, on Rge Rd 125.
Site #11		12:47 p.m. to 1:47 p.m.	6	45	27	W	140m	10%	Entrance to Site#11 on Rge Rd 103.
Site #19		2:07 p.m. to 3:07 p.m.	7	39	28	W-SW	40m	10%	Between Peace Pipe & CCS. 2:08pm-2 Carbotraps set up based on odours.
Site # 1		4:24 p.m. to 5:24 p.m.	6	43	25	W	100m	0%	No comments.
Site # 2		5:54 p.m. to 6:54 p.m.	2	58	7	NW-SW	Beaverlodge	0%	Face W on the N side of bldg. where MAML is housed.
Site #13	27-Oct	8:38 a.m. to 9:38 a.m.	1	59	16	SW	800m	5%	1.1 km N of Twp Rd 754 at Site#13A. 8:56am-2 Carbo traps (#54&59) set based on odours&elevated RHC readings.
Site #13		9:45 a.m. to 10:45 a.m.	5	44	8	SE-SW	490m SW	5%	Located at 08-29-75-9W6. Site is 500m N of Twp Rd 754.
Site #14		11:04 a.m. to 12:04 p.m.	8	33	5	W-SW	800m	5%	No comments.
Site #26		12:16 p.m. to 1:16 p.m.	7	31	10	W-SW	70m	0%	30m S of Twp Rd 752 on Rge Rd 91.
Site #16		1:25 p.m. to 2:35 p.m.	7	33	8	S	20m	0%	Adjacent to Site#16 on Rge Rd 90.
Site #17		2:59 p.m. to 3:59 p.m.	6	42	13	SE	900m	0%	1.4 km N of Hwy 59, downwind of Sit #17.
Site #19		4:32 p.m. to 5:32 p.m.	4	53	11	NE	40m	0%	Between Peace Pipe& CCS La Glace. Site chosen to measure downwind of CCS. 4:27pm-There are 3 diesel trailers in the yard. PAH very low so diesel trucks not likely interfering.

Appendix B – Data Collected by the Volatile Organic Compound Monitoring

Table B.1 Volatile organic compound (BTEX) concentrations (µg/m³) in the County of Grande Prairie (Sites #1 to #14)

Site #	Location	Installed	Removed	Duration	Benzene	Toluene	Ethylbenzene	Xylenes	Comments
Site # 1	Canadian Hunter Elmworth gas plant	Jun17 @ 08:15	Jun17 @ 09:15	1hr	**57.0**	63.0	3.0	17.0	Odours from plant although not very strong. Source unknown.
		Jun17 @ 08:16	Jun18 @ 08:17	24hrs	0.1	0.1	0.1	<0.3	
		Oct 26 @ 16:26	Oct 26 @ 17:26	1 hr	<1.4	<1.4	<1.4	<4.2	Downwind of dehydrator or compressor.
Site # 2a	3.5 mi. N of #2 (Next to odour injection facility)	Oct 23 @ 08:59	Oct 23 @ 09:59	1 hr	<1.5	<1.5	<1.5	<4.5	Natural gas injection facility.
Site # 2	Beaverlodge Agriculture Research Farm (Regional Background Site)	Apr 8 @ 08:00	Apr 9 @ 09:00	24hrs	<0.07	<0.07	<0.07	<0.2	Regional background site.
		Apr 11 @ 08:00	Apr 12 @ 08:00	24hrs	0.6	0.2	<0.07	<0.2	
		Apr 16 @ 07:54	Apr 17 @ 07:35	24hrs	0.4	0.2	<0.07	<0.2	
		Apr 19 @ 08:00	Apr 20 @ 08:20	24hrs	0.1	0.1	<0.07	<0.2	
		Jun 15 @ 07:13	Jun 16 @ 07:13	24hrs	0.2	0.3	0.1	0.2	
		Jun 18 @ 07:13	Jun 19 @ 07:15	24hrs	0.1	0.3	0.1	0.2	
		Jun 24 @ 07:15	Jun 25 @ 07:15	24hrs	0.1	0.1	<0.1	<0.2	
		Jun 27 @ 06:50	Jun 28 @ 06:50	24hrs	0.1	0.1	<0.1	<0.2	
		Oct 14 @ 07:30	Oct 15 @ 07:52	24hrs	0.6	0.3	<0.07	0.3	
		Oct 17 @ 07:42	Oct 18 @ 07:42	24hrs	0.3	0.1	<0.07	<0.2	
		Oct 22 @ 08:06	Oct 23 @ 09:13	24hrs	0.4	1.5	0.3	1.9	
		Oct 25 @ 07:25	Oct 26 @ 07:25	24hrs	0.3	0.4	<0.07	0.3	
Site # 3	Crestar Goodfare gas plant and battery station	Jun 20 @ 08:30	Jun 20 @ 14:30	6hrs	28.0	40.0	5.1	35.0	Readings from plant operations, likely not from main stacks. Several vents on the plantsite possible sources. Sources low volume, plumes narrow and low to the ground.
		Jun 25 @ 08:51	Jun 25 @ 09:51	1hr	**56.0**	26.0	2.0	7.0	Wind light NE. Sample at plant fenceline, 25-30m from road.
		Oct 15 @ 08:33	Oct 15 @ 09:33	1hr	**47.0**	118.9	8.9	69.5	Odour from a 4' high vent pipe 44m away on E edge of compound.
		Oct 23 @ 08:11	Oct 23 @ 09:11	1hr	26.6	53.2	2.8	24.9	Entire area has odours. Light winds.
		Oct 26 @ 08:24	Oct 26 @ 09:24	1hr	**49.3**	198.6	13.4	114.7	Downwind of 4' pipe.
Site # 6a	Van Tiessenhausen residence	Apr 13 @ 13:30	Apr 13 @ 16:30	3hrs	<0.07	<0.07	<0.07	<2.0	Complaint based & odours detected.
		Apr 13 @ 13:30	Apr 13 @ 19:30	6hrs	0.6	<0.3	<0.3	<0.9	
Site # 8	Martin Lake area	Dec 1 @ 12:15	Dec 2 @ 07:15	19hrs	0.9	0.7	0.1	0.5	No comments.
Site # 9	UPR Knopcik gas plant	Apr 8 @ 13:04	Apr 9 @ 14:04	24hrs	1.0	0.6	<0.07	0.4	No comments.
		Apr 8 @ 13:02	Apr 8 @ 14:02	1hr	3.3	1.7	<2.0	<5.0	
		Jun 28 @ 12:10	Jun 28 @ 13:10	1hr	21.0	9.0	<2.0	5.0	20m from small white tank, between tank and road. THC picked up by MAML facing S & adjacent to tank on Rge Rd 11-2.
		Oct 15 @ 15:56	Oct 15 @ 16:56	1hr	<1.4	<1.4	<1.4	<4.2	Propane type odours, RHC & NO2 readings on MAML.
		Oct 18 @ 13:24	Oct 18 @ 14:24	1hr	3.9	<2.0	<2.0	<5.9	Propane odours likely from tanks on site.
		Oct 24 @ 15:59	Oct 24 @ 16:59	1hr	<1.5	<1.5	<1.5	<4.5	Odours from tanks.
Site #11	Rigel Knopcik gas plant	Apr 12 @ 17:11	Apr 12 @ 18:11	1hr	<2.0	<2.0	<2.0	<5.0	No comments.
		Apr 21 @ 13:46	Apr 21 @ 14:46	1hr	1.7	<2.0	<2.0	<5.0	Odours & RHC readings.
		Jun 15 @ 13:04	Jun 15 @ 14:04	1hr	8.0	4.0	<2.0	<6.0	No comments.
		Jun 15 @ 13:02	Jun 16 @ 13:02	24hrs	7.8	5.8	0.2	1.1	
Site #13	East facility: Crestar Valhalla gas plant	Jun 24 @ 11:18	Jun 24 @ 12:18	1hr	2.0	2.0	<2.0	<6.0	No comments.
		Jun 24 @ 11:18	Jun 25 @ 11:18	24hrs	0.1	1.8	0.1	0.8	
Site #13a	West facility: Anderson Oil and Gas Valhalla facility	Oct 27 @ 08:57	Oct 27 @ 09:57	1hr	<1.4	<1.4	<1.4	<4.2	Odours and slight RHC readings on MAML.
Site #14	AEC West Valhalla battery	Apr 19 @ 10:00	Apr 19 @ 11:00	1hr	<2.0	<2.0	<2.0	<5.0	Odours.
		Apr 19 @ 09:53	Apr 20 @ 09:53	24hrs	0.4	1.2	<0.07	0.5	

Table B.2 Volatile organic compound (BTEX) concentrations (µg/m³) in the County of Grande Prairie (Sites #16 to #28)

Site #	Location	Installed	Removed	Duration	Benzene	Toluene	Ethylbenzene	Xylenes	Comments
Site #16	Petro Canada Valhalla gas plant	Apr 16 @ 12:19	Apr 16 @ 13:19	1hr	<2.0	<2.0	<2.0	<5.0	Odours.
		Apr 16 @ 12:19	Apr 17 @ 13:00	24hrs	0.5	1.0	0.1	0.6	
		Oct 16 @ 13:37	Oct 16 @ 14:37	1hr	6.7	14.5	<2.0	<5.9	Sour condensate type odour.
Site #18	Crestar Wembley gas plant	Dec 1 @ 20:00	Dec 2 @ 03:00	19hrs	3.0	2.7	0.6	2.5	No comments.
		Jun 23 @ 15:16	Jun 24 @ 15:16	24hrs	<0.1	0.1	<0.1	<0.3	
		Jun 23 @ 16:05	Jun 23 @ 17:05	1hr	<2.0	1.0	<2.0	<5.0	
Site #18a	Crestar Wembley Battery 8-19-73-8 W6	Jun 15 @ 16:44	Jun 15 @ 17:44	1hr	25.0	23.0	2.0	12.0	Very strong odours. MAML 100yds from tube samplers.
		Jun 15 @ 16:51	Jun 16 @ 16:51	24hrs	1.0	1.6	0.1	0.3	Odours indicated.
		Jun 23 @ 15:16	Jun 23 @ 16:16	1hr	14.0	19.0	5.0	21.0	Sample based on odours from the battery.
		Oct 16 @ 16:17	Oct 16 @ 17:17	1hr	4.2	9.0	<1.4	5.6	No comments.
		Oct 22 @ 16:25	Oct 22 @ 17:25	1hr	<1.5	4.4	<1.5	<4.5	Odour from tanks at battery site.
Site #19	CCS La Glace & Peace Pipe	Apr 10 @ 10:18	Apr 10 @ 11:18	1hr	10.0	37.0	6.7	80.0	Odour & THC readings on MAML.
		Apr 11 @ 19:10	Apr 12 @ 19:10	24hrs	1.8	2.6	0.4	3.7	Odour & THC readings on MAML.
		Apr 17 @ 17:30	Apr 17 @ 18:30	1hr	3.3	3.3	<2.0	<5.0	Odours from CCS La Glace.
		Apr 17 @ 17:30	Apr 18 @ 17:30	24hrs	2.2	2.6	0.4	2.2	Odours.
		Apr 20 @ 13:40	Apr 20 @ 14:40	1hr	6.7	17.0	1.7	20.0	Odours from CCS La Glace.
		Apr 20 @ 13:48	Apr 21 @ 13:48	24hrs	4.3	6.9	1.6	9.0	Odours from CCS La Glace at start of sample.
		Jun 15 @ 15:16	Jun 15 @ 16:15	1hr	**32.0**	110.0	13.0	110.0	Readings from CCS La Glace. Cause of odours unknown. Plant operator said some odours may be from contaminated soils on the site.
		Jun 15 @ 15:15	Jun 16 @ 14:30	23.21hrs	5.9	13.0	10.1	30.0	Downwind of CCS La Glace.
		Jun 23 @ 16:56	Jun 23 @ 17:56	1hr	6.0	14.0	3.0	14.0	No comments.
		Oct 22 @ 17:20	Oct 22 @ 18:20	1hr	<2.8	5.9	<2.0	<7.0	No comments.
		Oct 27 @ 16:25	Oct 27 @ 17:25	1hr	<1.4	<1.4	<1.4	<4.2	No comments.
		Oct 26 @ 14:17	Oct 26 @ 15:17	1hr	<1.4	<1.4	<1.4	<4.2	Downwind of Peace Pipeline.
Site #20	AEC West Saddle Hills gas plant (Sexsmith)	Apr 13 @ 17:28	Apr 13 @ 18:28	1hr	<2.0	<2.0	<2.0	<5.0	No comments.
Site #21	Talisman Teepee Creek gas plant	Oct 14 @ 17:09	Oct 14 @ 18:09	1hr	<1.9	1.9	<1.9	<5.6	Sulphur type odour (firecrackers).
Site #24	Talisman Manir Battery	Jun 23 @ 09:33	Jun 23 @ 10:33	1hr	2.0	4.0	<2.0	<6.0	No comments.
		Jun 23 @ 09:33	Jun 24 @ 09:33	24hrs	0.2	0.2	0.1	0.2	
Site #26	Crestar Energy, Valhalla Oil Battery/Waterflood	Apr 19 @ 11:19	Apr 20 @ 11:19	24hrs	1.0	6.0	1.0	6.0	Odours & offscale RHC readings on MAML.
		Apr 19 @ 11:19	Apr 19 @ 12:20	1hr	3.3	12.0	1.7	10.0	
		Jun 19 @ 10:54	Jun 19 @ 11:54	1hr	2.0	2.0	<2.0	<6.0	No comments.
		Jun 27 @ 12:09	Jun 27 @ 13:09	1hr	11.0	15.0	2.0	17.0	Sample taken about 5m S of Twp 75-2 along fence of Site #26. No trucks unloading during monitoring from 11:46 to 12:46. Winds from the facility, but interference from oil on the road possible.
		Jun 27 @ 12:12	Jun 28 @ 12:12	24hrs	2.0	8.5	2.5	15.0	No comments.
		Oct 16 @ 10:20	Oct 16 @ 11:20	1hr	9.0	33.8	4.5	24.8	No comments.
		Oct 19 @ 10:14	Oct 19 @ 11:14	1hr	2.1	13.9	<2.1	11.8	Strong odour, possibly from SE tank array. Very narrow plume.
		Oct 24 @ 11:46	Oct 24 @ 12:46	1hr	<2.0	9.8	<2.0	6.7	Odour and instrument readings from tanks.
		Oct 27 @ 12:17	Oct 27 @ 13:17	1hr	<1.4	6.3	<1.4	5.6	Odours, RHC readings on MAML.
Site #27	AEC well site	Oct 15 @ 12:00	Oct 15 @ 13:00	1hr	<2.3	<2.3	<1.5	<4.5	New well site, 'frac' test underway.
		Oct 17 @ 11:37	Oct 17 @ 12:37	1hr	<2.0	<2.0	<2.0	<5.9	Diesel type odour from temporary flare under 'frac test'.
Site #28	Talisman Energy well site	Oct 14 @ 14:51	Oct 14 @ 15:51	1hr	<1.5	<1.5	<1.5	<4.5	Well test underway, large flare but no odours.
		Oct 15 @ 09:48	Oct 15 @ 10:48	1hr	<1.5	<1.5	<1.5	<4.5	Well test underway, 1/4 mile away, variable winds, slight odour.
		Oct 17 @ 14:10	Oct 17 @ 15:10	1hr	<2.0	4.8	<2.0	<5.9	Odours from temp. tanks used during 'single point' well test.

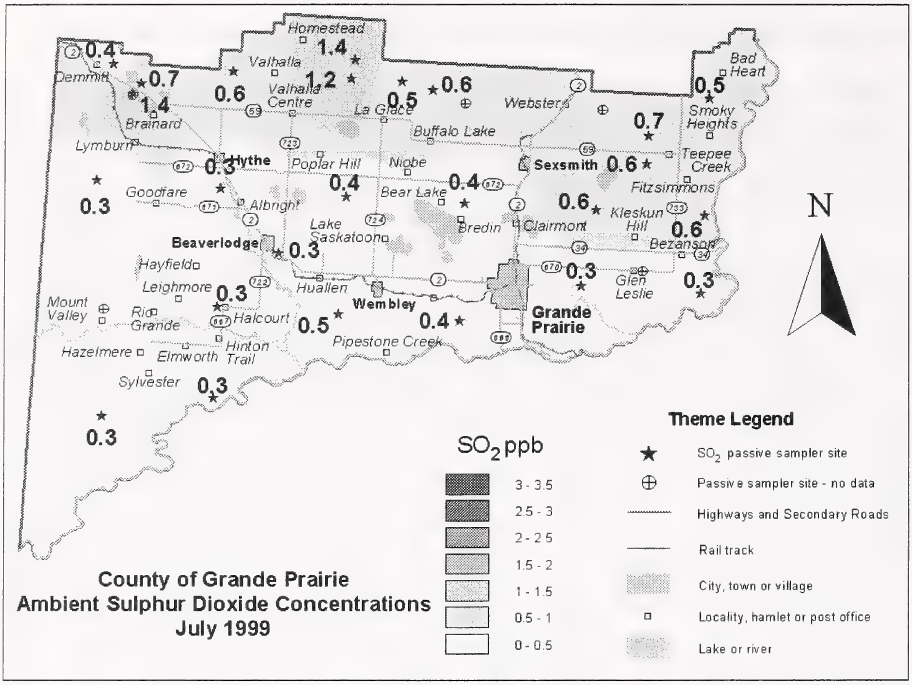
Appendix C – Data Collected by the Passive Monitoring Network

Table C.1 Monthly average sulphur dioxide concentrations from passive samplers in the County of Grande Prairie survey (ppb).

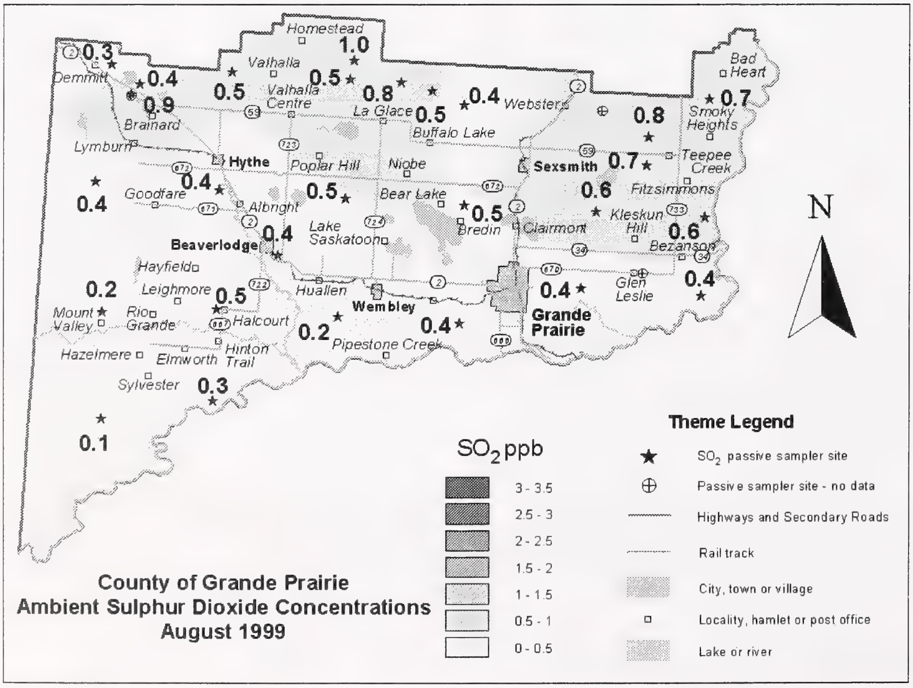
Site	Jul 1999	Aug 1999	Sep 1999	Oct 1999	Nov 1999	Dec 1999	Jan 2000	Feb 2000	Mar 2000	Apr 2000	May 2000	Jun 2000	Jul 2000	Aug 2000	14-month Average*
#1	0.3	0.4	0.1	0.2	0.4	0.6	1.1	0.7	0.7	0.3	0.3	0.3	0.4	0.2	**0.4**
#2	0.3	0.4	0.2	0.2	0.4	0.5	1.0	0.6	0.6	0.3	0.2	0.8	1.2	0.2	**0.5**
#3	1.4	0.9	1.2	1.4	1.1	2.9	2.4	1.4	1.2	0.9	0.8	n/a	0.5	1.0	**1.3**
#4	0.4	0.3	0.3	0.3	0.6	0.8	1.3	0.8	0.6	0.4	0.3	0.2	n/a	0.4	**0.5**
#5	0.7	0.4	0.5	0.7	1.1	1.3	1.3	1.4	1.3	0.7	0.5	0.3	0.6	0.6	**0.8**
#6	0.6	0.5	0.4	0.3	0.6	1.1	1.3	0.7	0.8	0.4	0.2	n/a	n/a	n/a	**0.6**
#7	1.2	0.5	0.4	0.3	1.0	1.0	1.5	1.6	0.8	0.6	0.5	0.6	0.1	1.1	**0.8**
#8	1.4	1.0	0.5	1.0	n/a	2.7	3.4	2.9	1.6	2.3	1.4	1.3	0.1	0.4	**1.5**
#9	0.5	0.8	0.3	0.3	0.7	1.3	1.6	1.7	1.2	0.8	1.5	1.5	0.1	0.6	**0.9**
#10	0.6	0.5	0.5	n/a	0.8	1.2	2.7	1.2	0.8	0.6	0.4	0.6	0.1	0.4	**0.8**
#11	n/a	0.4	0.5	0.3	0.6	0.7	1.2	1.0	0.8	0.4	0.4	0.5	0.4	0.2	**0.6**
#12	n/a	n/a	1.1	0.7	1.5	1.8	2.9	2.2	1.0	0.9	0.4	0.5	0.6	0.3	**1.2**
#13	0.5	0.7	0.9	0.6	1.5	2.0	3.1	3.1	1.4	0.8	0.5	0.4	0.4	0.4	**1.2**
#14	0.7	0.8	0.9	0.8	0.9	1.2	1.4	1.5	1.4	0.5	0.5	0.5	0.6	0.4	**0.9**
#15	n/a	n/a	0.4	0.3	0.6	0.9	1.1	1.4	0.8	0.5	0.4	0.4	0.4	0.2	**0.6**
#16	0.6	0.7	0.7	0.4	0.7	1.0	1.3	1.4	1.0	0.4	0.4	0.5	0.4	0.2	**0.7**
#17	0.6	0.6	0.4	0.3	0.8	1.0	1.1	1.4	0.8	1.2	0.2	0.4	0.4	0.4	**0.7**
#18	0.6	0.6	0.6	0.5	1.2	1.8	1.9	2.3	1.0	0.4	0.4	1.0	0.4	0.4	**0.9**
#19	0.4	0.5	0.3	0.3	1.0	1.5	1.4	1.4	1.2	0.5	0.5	0.5	0.3	0.2	**0.7**
#20	0.4	0.5	0.2	0.2	0.7	1.0	1.4	1.1	0.8	0.4	0.5	0.4	0.3	0.2	**0.6**
#21	n/a	0.2	0.2	0.2	0.2	0.6	0.8	0.4	0.4	0.3	0.2	0.3	0.2	0.2	**0.3**
#22	0.3	0.5	0.2	0.2	0.3	0.7	1.0	0.4	0.5	0.3	0.2	0.3	0.2	0.1	**0.4**
#23	0.5	0.2	0.2	0.2	0.4	1.5	0.8	0.7	0.6	0.0	0.3	0.3	0.2	0.2	**0.4**
#24	0.4	0.4	0.3	0.3	0.4	0.8	0.7	0.8	0.6	0.3	0.3	0.4	0.2	0.2	**0.4**
#25	0.3	0.4	0.2	0.2	0.5	0.9	0.9	1.2	0.6	0.4	0.3	0.4	0.3	0.2	**0.5**
#26	0.3	0.4	1.6	0.3	0.4	0.7	0.8	0.7	0.6	0.4	0.2	0.3	0.3	0.2	**0.5**
#27	0.3	0.1	0.2	0.1	0.2	0.4	0.5	0.4	0.4	0.2	0.1	0.2	0.1	0.1	**0.2**
#28	0.3	0.3	0.2	0.1	0.2	0.5	0.6	0.5	0.4	0.2	0.1	0.2	0.3	0.1	**0.3**
#29	n/a	n/a	n/a	1.3	0.8	2.0	2.2	1.2	1.2	0.7	n/a	0.7	0.8	0.8	**1.2**
#30	0.3	0.4	0.2	0.3	n/a	0.8	1.4	0.8	0.7	0.6	n/a	0.4	0.2	0.3	**0.5**
Average	**0.6**	**0.5**	**0.5**	**0.4**	**0.7**	**1.2**	**1.5**	**1.2**	**0.9**	**0.6**	**0.4**	**0.5**	**0.4**	**0.4**	**0.7**

n/a Indicates sample was missing, damaged or destroyed.

* **The annual guideline for SO_2 is 11 ppb.**



County of Grande Prairie
Ambient Sulphur Dioxide Concentrations
July 1999



County of Grande Prairie
Ambient Sulphur Dioxide Concentrations
August 1999

Figure C.1 Sulphur dioxide concentrations (ppb) from the County of Grande Prairie passive sampling network in July and August 1999.

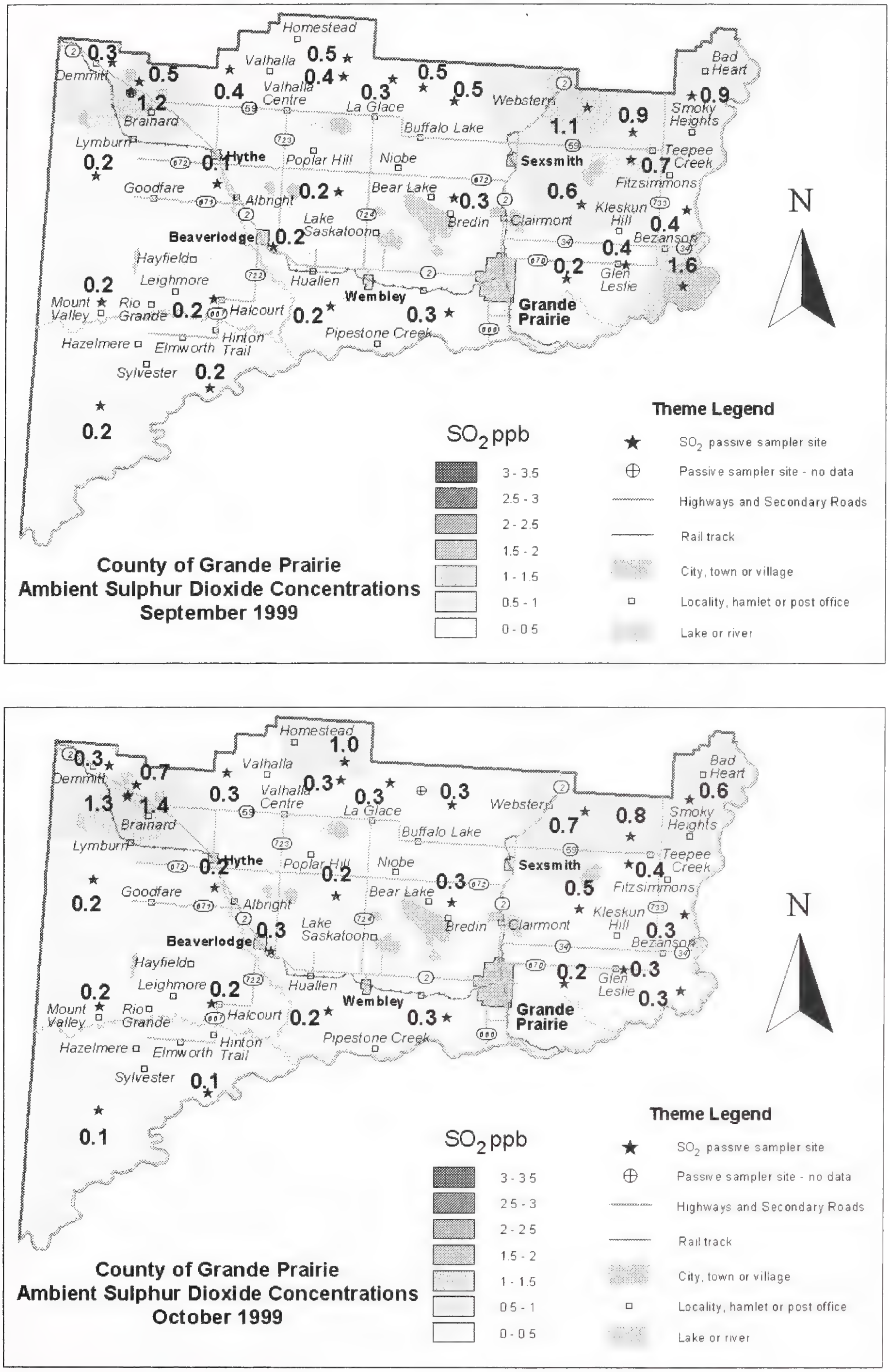


Figure C.2 Sulphur dioxide concentrations (ppb) from the County of Grande Prairie passive sampling network in September and October 1999.

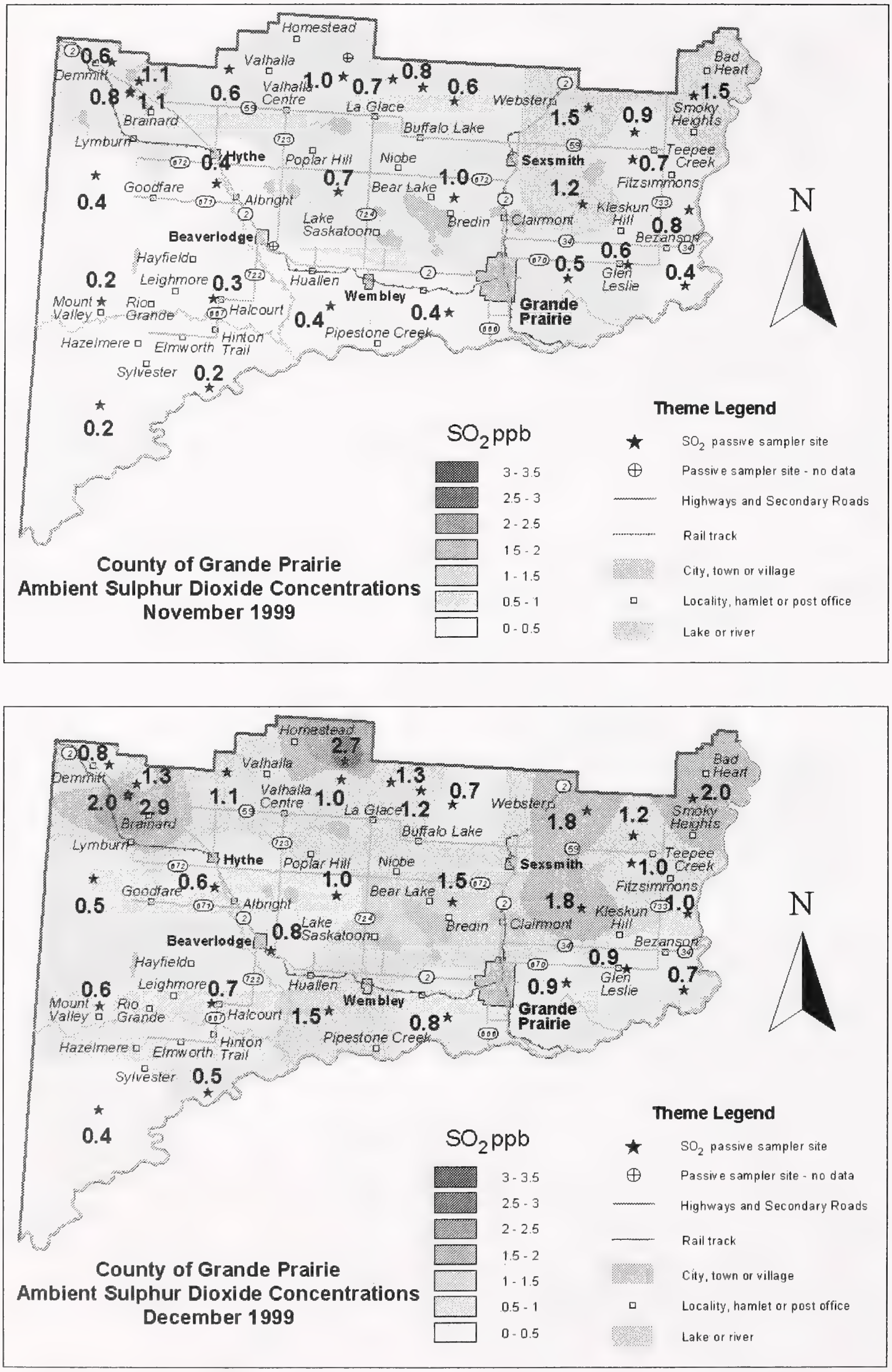


Figure C.3 Sulphur dioxide concentrations (ppb) from the County of Grande Prairie passive sampling network in November and December 1999.

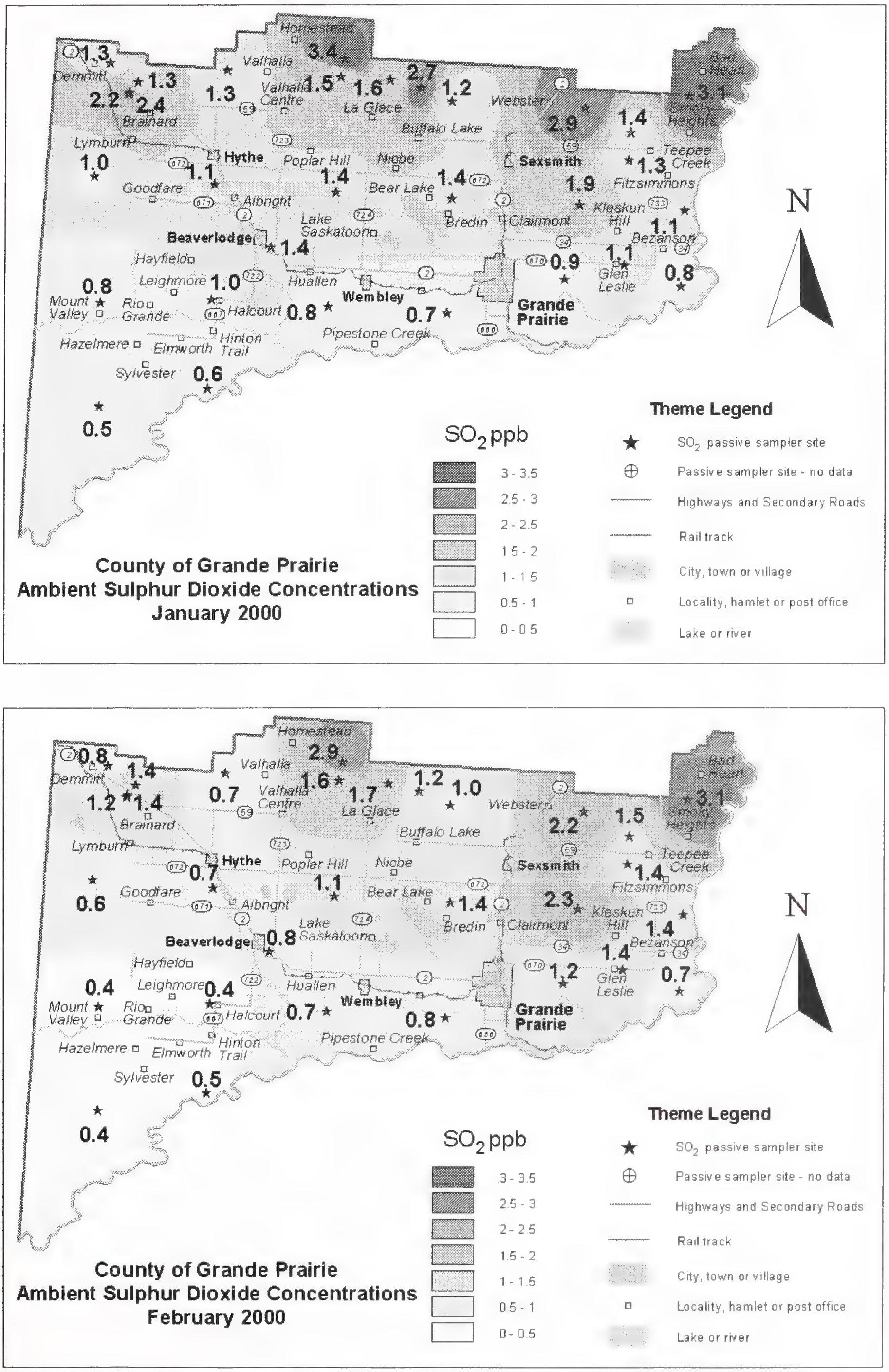


Figure C.4 Sulphur dioxide concentrations (ppb) from the County of Grande Prairie passive sampling network in January and February 2000.

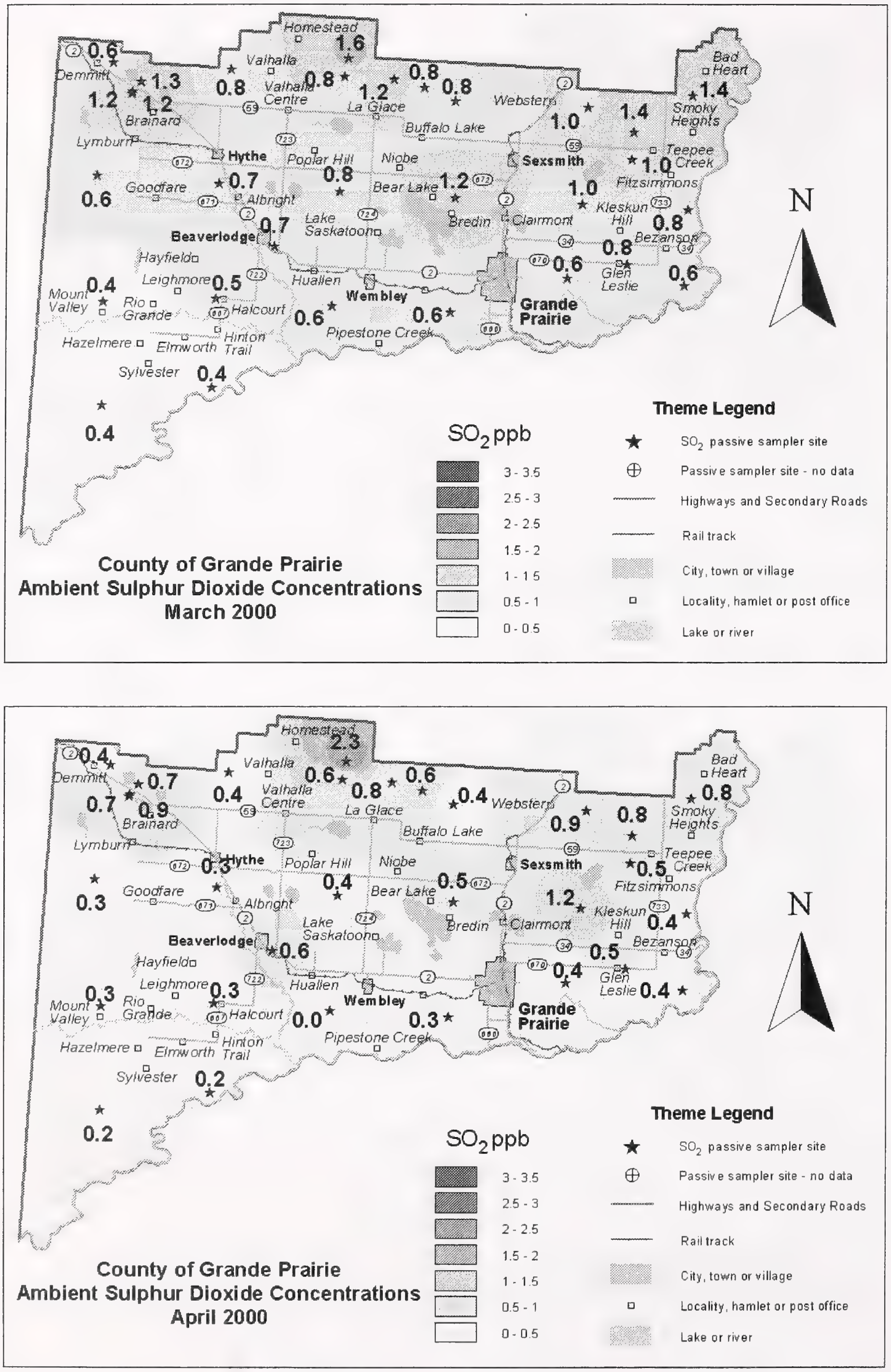
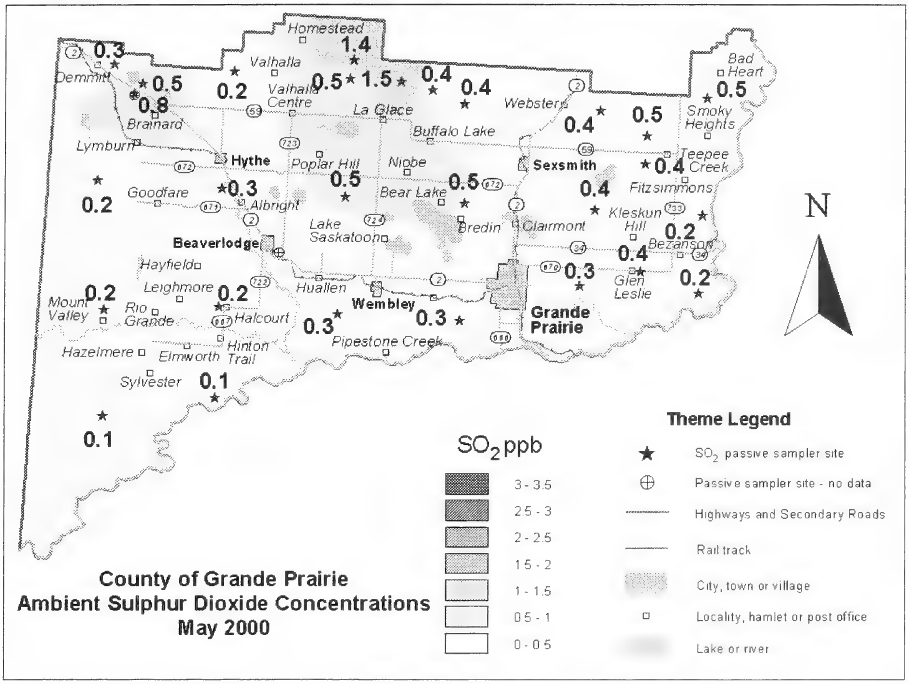


Figure C.5 Sulphur dioxide concentrations (ppb) from the County of Grande Prairie passive sampling network in March and April 2000.



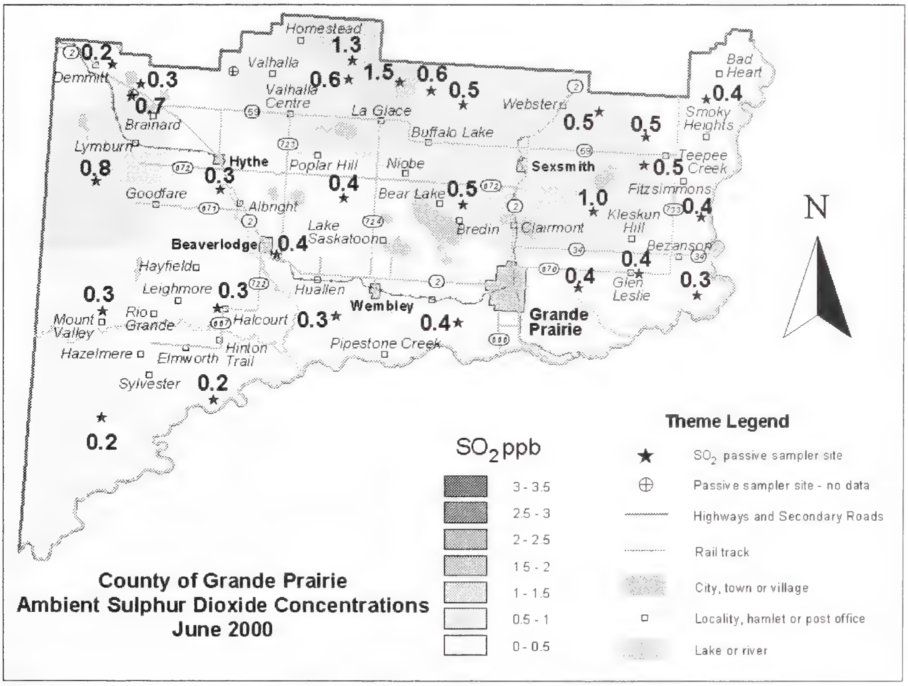


Figure C.6 Sulphur dioxide concentrations (ppb) from the County of Grande Prairie passive sampling network in May and June 2000.

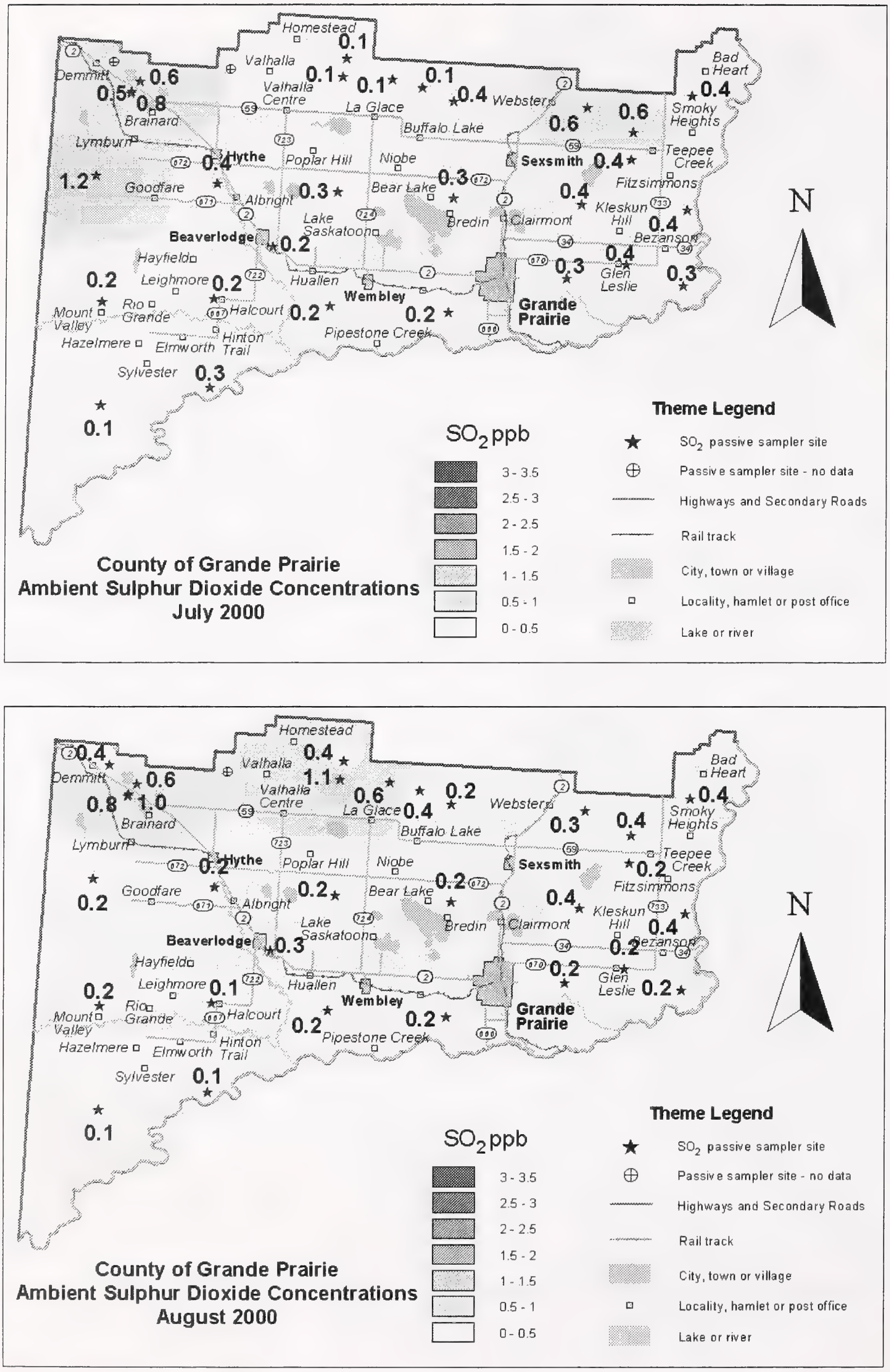


Figure C.7 Sulphur dioxide concentrations (ppb) from the County of Grande Prairie passive sampling network in July and August 2000.

Table C.2 Sulpur dioxide and concentrations (ppb) at Alberta monitoring stations during passive monitoring period.*

Station	Jul 1999	Aug 1999	Sep 1999	Oct 1999	Nov 1999	Dec 1999	Jan 2000	Feb 2000	Mar 2000	Apr 2000	May 2000	Jun 2000	Jul 2000	Aug 2000	14-Month Average
Grande Prairie Area Passive Network	0.6	0.5	0.5	0.4	0.7	1.2	1.5	1.2	0.9	0.6	0.4	0.5	0.4	0.4	**0.7**
Beaverlodge (passive station)	0.3	0.4	0.2	0.3	n/a	0.8	1.4	0.8	0.7	0.6	n/a	0.4	0.2	0.3	**0.5**
Beaverlodge (continuous monitor)[1]	0.3	0.4	0.3	0.2	0.4	0.7	1.0	0.8	0.7	0.5	0.4	0.4	0.3	0.2	**0.5**
Calgary East[1]	2.2	2.7	3.4	3.0	4.2	4.1	4.3	4.3	2.5	2.2	2.0	1.9	2.0	2.4	**2.9**
Edmonton East[1]	1.6	2.2	1.7	3.3	2.6	3.2	3.0	3.7	2.9	1.8	2.4	2.0	1.7	2.4	**2.5**
Fort Saskatchewan[1]	2.1	1.9	2.5	3.1	2.5	1.6	2.4	2.6	1.9	1.2	0.6	0.6	0.3	0.2	**1.7**
Red Deer[1]	n/a	n/a	n/a	n/a	n/a	1.2	1.5	1.7	1.0	0.6	0.5	0.3	0.2	0.3	**0.8**
Buffalo Viewpoint[2]	0.8	1.5	1.2	0.4	0.9	0.5	0.7	1.1	0.7	1.8	2.5	2.9	2.3	1.0	**1.3**
Fort Chipewyan[2]	n/a	n/a	n/a	0.4	0.4	0.7	0.5	0.4	0.2	0.1	0.0	0.1	0.2	0.1	**0.3**
Fort Mckay[2]	0.9	1.3	1.1	0.8	0.9	1.3	1.6	1.6	1.0	1.1	0.3	0.9	0.8	0.5	**1.0**
Fort McMurray (Athabasca Valley)[2]	0.9	0.4	1.0	0.6	0.7	1.0	1.2	0.9	0.7	1.0	0.9	0.8	0.6	0.6	**0.8**
Fort McMurray (Patricia McInnes)[2]	1.2	0.7	1.0	0.6	1.0	1.1	1.7	1.4	0.8	1.4	1.3	1.4	0.6	1.1	**1.1**
Lower Camp[2]	1.3	2.6	2.2	1.5	0.9	1.0	0.8	1.7	1.7	1.9	1.3	3.1	2.4	1.7	**1.7**
Mannix[2]	2.4	3.2	2.0	1.0	2.1	2.7	4.0	3.0	2.5	2.7	2.2	3.4	1.9	1.5	**2.5**
Mildred Lake[2]	2.0	1.9	1.8	3.2	2.4	2.1	2.5	1.8	1.4	1.4	1.7	2.8	3.3	2.0	**2.2**
Carrot Creek[3]	0.8	0.9	0.9	1.2	1.7	1.8	2.5	2.8	1.9	0.6	0.5	0.8	n/a	n/a	**1.4**
Tomahawk[3]	0.7	0.9	1.0	0.9	1.2	1.1	2.2	2.1	1.9	1.3	0.9	0.6	n/a	n/a	**1.2**
Violet Grove[3]	0.6	0.5	0.6	0.9	1.2	1.3	2.5	2.4	1.7	0.7	0.3	n/a	n/a	0.4	**1.1**
Sherwood Park[4]	1.4	1.5	2.1	2.0	2.2	1.5	2.3	2.7	2.5	1.2	1.3	1.6	0.9	2.0	**1.8**

1 Permanent station operated by Alberta Environment.
2 Permanent station operated by the Wood Buffalo Environmental Association
3 Permanent station operated by the West Central Airshed Society.
4 Permanent station operated by the Strathcona Industrial Association.
n/a Data not available.
* All data from permanent stations obtained from the Alberta Ambient Air Data Management System (http://www.casadata.org).

Table C.3 Ozone concentrations (ppb) at Alberta monitoring stations during passive monitoring period.*

Station	Jul 1999	Aug 1999	Sep 1999	Oct 1999	Nov 1999	Dec 1999	Jan 2000	Feb 2000	Mar 2000	Apr 2000	May 2000	Jun 2000	Jul 2000	Aug 2000	14-Month Average
Grande Prairie Area Passive Network	19	18	16	24	17	29	24	30	34	30	28	23	19	16	**24**
Beaverlodge (passive sampler)	29	27	20	28	n/a	30	26	32	35	34	33	29	24	21	**28**
Beaverlodge (continuous monitor)[1]	25	26	23	28	21	28	25	26	37	41	38	30	26	22	**28**
Calgary Central[1]	17	15	12	12	7	9	7	9	16	24	28	22	20	18	**15**
Calgary East[1]	20	15	15	14	8	10	7	12	20	26	30	21	21	19	**17**
Calgary Northwest[1]	26	20	17	19	13	16	13	17	26	32	35	27	26	23	**22**
Edmonton Central[1]	17	18	13	14	7	11	8	10	19	26	26	21	19	15	**16**
Edmonton East[1]	23	23	19	19	9	16	15	17	28	36	32	28	25	18	**22**
Edmonton Northwest[1]	19	17	13	13	6	10	10	9	19	26	29	25	23	18	**17**
Fort Saskatchewan[1]	22	22	20	19	9	17	15	15	30	35	33	28	22	19	**22**
Red Deer[1]	n/a	n/a	n/a	n/a	n/a	5	7	12	29	34	34	28	23	20	**23**
Fort Chipewyan[2]	22	20	20	22	22	26	27	35	36	38	32	29	24	17	**26**
Fort Mckay[2]	19	17	16	18	12	15	11	19	28	32	26	20	18	13	**19**
Fort McMurray (Athabasca Valley)[2]	21	18	16	16	12	14	10	14	25	29	26	22	18	13	**18**
Fort McMurray (Patricia McInnes)[2]	22	19	20	21	18	20	18	27	35	34	30	25	20	16	**23**
Carrot Creek[3]	28	30	21	26	13	26	20	26	38	42	38	33	n/a	n/a	**29**
Hightower Ridge[3]	37	36	36	46	43	44	44	50	51	64	52	43	38	36	**44**
Steeper[3]	30	29	28	40	36	40	39	42	46	56	48	40	33	27	**38**
Tomahawk[3]	27	28	25	29	16	26	21	30	41	40	41	30	n/a	n/a	**30**
Violet Grove[3]	28	23	21	32	24	35	30	41	45	50	45	n/a	n/a	24	**33**

1 Permanent station operated by Alberta Environment.
2 Permanent station operated by the Wood Buffalo Environmental Association
3 Permanent station operated by the West Central Airshed Society.
n/a Data not available.
* All data from permanent stations obtained from the Alberta Ambient Air Data Management System (http://www.casadata.org).

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